# THE SPATIAL PATTERN OF ECONOMIC RENTS AND URBAN LAND VALUE MODEL AROUND AN AIRPORT AREA: THE CASE STUDY OF SUVARNABHUMI INTERNATIONAL AIRPORT, THAILAND

by

Chakarin Bejrananda

B.Arch., Rangsit University, 1998

MURP, University of Colorado Denver, 2002

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Chakarin Bejrananda

has been approved for the

Design and Planning Program

by

Carolyn McAndrews, Chair

Yuk Lee, Advisor

Bruce Janson

Peeradorn Kaewlai

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Bejrananda, Chakarin, (Ph.D., Design and Planning)

The Spatial Distribution of Airport Economic Rents and Urban Land Value Model Around The Airport Area: The Case Study of Suvarnabhumi International Airport, Bangkok, Thailand

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## ABSTRACT

With the rise of the importance of air transportation in the 21st centuries, the role of economics in airport planning and decision-making has become more important to the urban structure and land value around it. The relationship between the airport and land value in urban areas has attracted more attention from academic researchers. However, there has been little research on the factors that affect the prices of land relatively to the airport location.

Using New Bangkok International Airport (Suvarnabhumi International Airport) as a case study, this dissertation applied Alonso's bid rent model explaining the relationship between an airport and its distribution to the urban land values. In addition, it developed a hedonic pricing model to determine the influential factors that reflect on the prices of land over four time periods of airport development (before airport development, after the airport site proposed, during airport construction, and after the opening of the airport).

The statistical analysis results confirm that Alonso's model can be used to explain the impact of the new airport only for the northeast quadrant, while proximity to the airport showed the inverse relationship with the land value of all six types of land use activities through four periods of time. In addition, the empirical results of the hedonic model confirm that the presence of the airport consistently affected land value for all

types of land use activities for three quadrants (northwest, northeast, and southwest). The distance to the Bangkok CBD has a strong relationship to the land values through four time periods for the northwest quadrant. Also, the distance to transportation networks, such as main streets and Bang-Na Trad highway, became important factors affecting urban land value for all four quadrants through four periods of time.

The findings of this dissertation are not only useful for an understanding the impacts of the airport on urban land value in Thailand, but also valuable to regional and urban development for real estate developers, policy makers, and the Thai government to provide an appropriate plan for future developments in the airport area. Furthermore, the analytical methods and the empirical results of this dissertation can be applied to estimate the impacts of other public projects, such as subway stations, airport-link terminal, sport stadium, and marinas, on the urban land value.

The form and content of this abstract are approved. I recommend its publication.

Approved: Yuk Lee

## DEDICATION

I dedicate this work to my beloved family for their support, encourage, and understanding. The most important two people in my life who have always supported me are my parents (Dr. Preecha Petcharanond and Mrs. Jirapa Petcharanond). They are always there for me to be patient and wait for my success with the degree. The next three important people are Associate Prof. Somskaow Bejranonda, Associate Prof. Monsicha Bejrananda, and Dr. Manivara P. Krone, who always support me with helpful ideas, even encourage me to move forward while I was upset and disappointed, and believe in me.

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Also, I would like to thank the staff at Bureau of Property Evaluation, The Treasury Department, Ministry of Finance, who always help me look for the data. My appreciation also go to the Division Map, Royal Thai Survey Department, Royal Thai Armed Forces Headquarters for providing aerial photos of the study area for 1987, 1995, and 2009. Furthermore, I would like to thank the Office of Surveying and Mapping Technology, Land Development Department, Ministry of Agriculture Cooperative for the aerial photo of the study area for 2002.

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# CHAPTER I

## INTRODUCTION AND HISTORICAL BACKGROUND

With the emergence of the global economy, air transportation has become more important than ever before. Each year millions of people travel through the world's airports. Decreasing costs of airline travel, competition of airline companies, and the advantages of faster travel time are some of the factors that have given people more opportunities to travel by air than by other modes of transportation. Not only increasing numbers of the passengers but also commodities pass through airports each year. (Kasarda 1999) states that the success of businesses will rely not only on the continual improvement of product quality, but also on fast response to distribute these products to customers around the world. Therefore, nations are pressed to build more airports and expand existing ones. Nowadays air transportation infrastructure has become a crucial catalyst for economic growth, creating employment opportunities as well as stimulating trade and commerce. It is abundantly clear that airports now impact the economy at international, national, regional, and urban levels.

As Thailand increases its involvement in the global economy, the capital city of Bangkok faces the urgent need of a new airport to support the growth of the metropolitan area and the national economy. Bangkok needs a new airport because the old Bangkok international airport, Don Muang Airport, has reached a carrying capacity of 45 million passengers and does not have enough land to expand because it is located within an urban area. Don Muang was officially opened as a Royal Thai Air Force base on March 27, 1914. Commercial flights started in 1924. Don Muang Airport was closed for few months since the opening of Suvarnabhumi Airport in September 2006. But with high

operating costs and safety concerns over cracked runways at the new airport, on January 30, 2007 the Ministry of Transport recommended temporarily reopening Don Muang during the repair and improvement of Suvarnabhumi Airport. Now, domestic flights that require no flight connections still operate out of Don Muang Airport.

Don Muang was an important hub of Asia and the hub of Thai Airways International prior to its closure. At its peak in 2005, it served most air traffic in Thailand, with 80 airlines operating 160,000 flights and handling over 38,000,000 passengers and 700,000 tons of cargo. At that time it was the eighteenth busiest airport in the world and second in Asia by passenger volume (Airport Councils International Statistic, ACI). The New Bangkok International Airport was proposed in 1960 in order to replace the overloaded and unexpandable nature of the Don Muang Airport.

**Current Problems of Urbanization in Bangkok and the Airport Development Area**

Not unlike a typical city in other developing countries, Bangkok is one of the fast growing cities in Asian. Rapid population growth and the concentration of economic activities have brought many urban problems, such as un-controlled expansion of the city (urban sprawl), lack of services and facilities, and conflicting patterns of urban land use.

Since the Bangkok has been in a transition period of rapid growth of both population and economic activities, the city is enhancing its role to decentralize into suburban areas. Unfortunately, the expansion of the city is over-controlled, while the real estate developments have converted undeveloped and agriculture land into residential housing projects and golf courses. With the considerable expansion of the city, the growth of suburban and exurban areas in the extended region has been driven not only by the congestion in the core area, but also by government policies, which encourage

residents and businesses to decentralize. The intention of the government policy is to relocate manufacturing industries to the east side of the Bangkok Metropolitan Region and to Samut Prakarn province, where the New Bangkok International Airport (Suvarnabhumi International Airport) is located. The area around the airport used to be agriculture lands. Since the plan for the new airport was proposed in 1960, the usages of the land have changed over the time, and agriculture land has been converted to industrial and residential developments (Tonmanee and Kuneepong, 2004). These dynamic changes have caused many problems in term of urban sprawl and urban development patterns.

Another major concern is the lack of services and facilities. The result of the rapid growth in economic development and the population in Bangkok is reflected in the quality of life, with inadequacies of public services such as water, sanitation, electricity, and paved streets (Basuki and Han, 2001). In term of the transportation problem, the congestion of the city becomes the major problem that affects the urban development patterns because the city is primarily driven by the road network rather than zoning regulations, government policies, and development controls. The lack of understanding of the relationship between land use and transportation systems has caused the problem of traffic congestion in the core area. In addition, the insufficient capacity of the street networks and the unsystematic nature of these street networks have caused traffic congestion in the core area (Tonmanee and Kuneepong, 2004).

The major problem of the urbanization in Bangkok and the airport development area is the conflicting pattern of urban land use. With the lack of land use regulation and policies, it is very common to find a mixture of various types of land use adjacent to each other. For example, in the eastern region of the Bangkok Metropolitan Area, industrial

factories are widespread throughout the area along the major street network (Srinagarindra Road, Wat King-Kaeo Road, Lad Krabang Road, Teparak Road, and Rom Klao Road), and corridor development (Bang Na-Trad Highway), while some of them are located adjacent to residential areas. These situations have increasingly affected the urban settlement patterns as well as the lives of people who live in those areas.

Due to the development of the New Bangkok International Airport, Suvarnabhumi International Airport, the economic impact of the airport has become a very controversial and much discussed issue. It has had a significant influence on both the surrounding area and the whole region in terms of economic impact, while it has attracted industrial and commercial development that clusters around the airport (Kasarda, 2000). As a consequence, this has led to increased land values around the airport. Since the announcement of the airport in mid 1990s until the beginning of operation in 2006, developers anticipated a tremendous increase in land value. Therefore, the expectation effect led the government to consider providing the infrastructure to support the urban growth in the airport development area in advance of its completion.

The objective of this dissertation includes the examination of the impacts of the development of Suvarnabhumi International Airport on land values at the airport and vicinity areas over time as well as the impacts of the airport on the distribution of the land use activities around it. More specifically, the dissertation will examine whether the urban land market around the airport area allocated efficiently for the different periods of time and what factors affected the price of land around the airport for the different time periods. Furthermore, this dissertation will seek to evaluate the spatial distribution of the

urban activities around the airport to determine if the land use activities around the airport have been used efficiently according to the urban land use theory of Alonso (1965).

A number of existing theories and models can be used to drive the investigation of the impact of the Suvarnabhumi International Airport on land value, such as von Thunen's agriculture land use theory (1826) and Alonso's urban land market theory (1964).von Thunen's agriculture land use theory (1826) primarily focused on analyzing the distribution pattern of agricultural activities by using the concept of economic rent. In 1965, von Thunen's agriculture land rent theory was applied to the urban land use context by William Alonso. Similarly to von Thunen's model, Alonso used the same context of agriculture land rent and generated a series of land use zones to explain the distribution of the land use within the city. Alonso argued that households determine their residential locations based on the trade-off between the costs of commuting and land costs, and residents choose their residential locations in order to maximize utilities. In terms of urban firms, these firms tradeoff between land costs and sales. In addition, they choose locations that maximize profit.

In addition, several alternative conceptual frameworks and schemes have been developed to understand location decisions of economic activities in the city. These include Weber (1929), Losch (1954), Isard (1956), Pred (1964), and Northham (1979) on manufacturing activities in the city, and also Christaller (1933), Losch (1954), Berry (1968), Lee and McCracken (1981, 2012), and Sakhakara (2011) on commercial and retail activities. Many location factors have been identified by these researchers, including scale economies, agglomeration economies, transportation costs, capital and

labor substitutions, product life circle, market and raw material location, cumulative attraction and interceptor strategies, suscipient and generative retail business.

Many empirical studies have been conducted on the land use patterns and changes within urban areas, but only a few studies have focused on urban economic development and land use impacts of the airports (Crowley, 1973; Weisbrod, Reed, and Neuwirth, 1993; Hakfoort, Poot, and Rietveld, 2001; Brueckner, 2003; Galoszewski, 2004; Forsyth, 2004; Green, 2006; Flores-Fillol and Nicolini, 2006; and Kasarda, 1999, 2001, 2006, 2009, 2010).

The study by Weisbrod, Reed, and Neuwirth is based on studies of the airports by Cambridge Systematics, Inc a private consulting firm, which surveyed the economic activities around five airports in Europe, Japan, and North America. Weisbrod and Reed took the survey results and developed a model to forecast the economic impact and planning for airport land area development. Weisbrod and Reed considered impacts in terms of airport facilities employment, directly related business activity, businesses attracted to the surrounding area, and spin-offs from the development. The results of the model may serve as a conceptual framework for this study.

Several studies on the impact of the airport on patterns of land use have received attention: the effects of an airport on land value (Crowley, 1973), Golaszewshi's study on location rents and the experiences of US airports (Golaszewski, 2004), locational and monopoly rents at the airport (Forsyth, 2004), and Aerotropolis: an aviation-linked space (Flores-Fillol and Nicolini, 2006).

Crowley's study (1973) looks at land value impacts of the airport. It is an attempt to investigate changes in land value in the vicinity of Toronto International Airport to

determine changes in the mix of residential, commercial, and industrial uses. He claims that there are two tendencies affecting the residential and commercial uses relative to the positive and negative influence of airports on land value. First, there are developments on residential and commercial uses in the area adjacent to the airport because of increasing demand for the particular real estate. Second, on the other hand, affected residents tend to move in the opposite direction from airport expansion because of the noise pollution, regulation controls for runway used, and landing and take off schedules (Crowley, 1973). As a result, there is a significant change in the price of land in the vicinity of the airport compared with the non-airport area. Also, the residential land values decrease during the period of change (expansion of the airport development area), and return to increasing values after that as a long-run trend. In addition, the mean price of the residential land value in the airport area seems to be higher than the area that is farther away from the airport (Crowley, 1973).

Similarly to Crowley's study, a study by Golaszewski (2004) on location rents and the experiences of US airports examines whether the airport can capture location rents from off- airport businesses that serve airport customers. In his analysis, location rents can apply both to on-airport activities and areas adjacent to the airport or to off-airport activities. The results of his study show that the largest airports, rather than medium and small airports, should be able to capture rents for on-airport and off-airport services. That is because of the low level of the activity and the privilege of the location at the airport. Also, Forsyth's study of locational and monopoly rents at the airport claims that the locational rents will increase when moving close to the operations of the airport, and the rents will decrease when moving further away from the airport. In

addition, land around the airport can create locational rents, and how high the rents are depends on how restricted this land supply is, as well as the attractiveness of the land related to the airport, and the distance to the airport (Forsyth, 2004).

## Research Questions and Hypotheses

According to the previous research, several questions can be raised with respect to the impacts of development of Suvarnabhumi International Airport on land values and other determinants that may affect the price of land in the airport vicinity during four time periods (prior to the airport, after the airport site was proposed, during the airport construction, and after the opening of the airport). This dissertation is based on the premise that airport development has impact on the distribution of urban land values, with high land values close to the airport and low land values further away from the airport because of the privilege of the location close to the airport. Also, the land values around the airport development area may be affected by other exogenous physical factors rather than the airport itself. Therefore, the research questions of this dissertation are: 1) whether land values for each type of land use activity been affected by proximity to the designated airport location within different quadrants and time periods; 2) how the urban land market around the airport allocates for different periods of time according to the urban land use theory; 3) if there are price impacts, what is the timing of these impacts; and 4) whether any factors impact the land values other than proximity to the designated airport location and how these factors impact the prices of land.

In order to answer the above questions, three hypotheses will be tested, the first two of which will relate to the spatial distribution of the urban land value and the third will relate to the determinants. Therefore, the context of Alonso's urban land market

theory (1964) has been utilized to construct the first two hypotheses. With the third hypothesis, there is the expectation that the other exogenous factors will affect the price of land around the airport area. Consequently, the three hypotheses are that: 1) land parcels around Suvarnabhumi International Airport had higher value than land parcels farther away from the airport because the airport can refer as the CBD with the clustering of businesses development around it; 2) there was no difference in average land values in all four quadrants over time periods; and 3) the land values were a function of physical factors.

## Research Methodology

The two methodologies that will be used to test the three hypotheses are the bid-rent model by Alonso (1964) and hedonic pricing model developed by Griliches (1961). The bid-rent model, which is known as simple regression, will be used to test the impact of the airport on the urban land value. Similarly to the Alonso's study, the proximity to the airport will be used to examine the changes in urban land values, while the price of land will increase with the closer distance to the airport. This test will be based on four assumptions that: the airport is the only one influential factor to affect the price of land, the transportation cost is equal in all direction, all sites are the same everywhere, and all land users have equal opportunities to access the land without any interference from the market economy and government policies. The result of the test will answer the question whether or not the airport has impact on the urban land value. In addition, the multivariate urban land value model (hedonic pricing model) will be used to test the third hypothesis by using the same context of multiple correlation and regression analysis to

investigate if there are any other exogenous factors that affect the changes in the urban land value rather than the airport itself.

To conduct an empirical analysis for this dissertation, the actual data will be collected from various agencies and professionals. The database for analyzing the impacts of the Suvarnabhumi International Airport on urban lane values will use historical aerial photos and land values from 1987 to 2009. The following sources contain the data that will be used for this dissertation:

1. Land value assessment of the study area for four periods of time (1987, 1995, 2002, and 2009) from Bureau of Property Evaluation, The Treasury Department, Ministry of Finance.
2. Aerial photos of the study area for year 1987, 1995, and 2009 from Division Map, Royal Thai Survey Department, Royal Thai Armed Forces Headquarters.
3. Aerial photo of the study area for year 2002 from Land Development Department, Ministry of Agriculture Cooperatives.

In reference to the analysis, there are two analytical methods, bid rent model and stepwise multivariate urban land value model, which will be used in this dissertation. The first method, bid rent model, is used to examine the relationship between land value and the proximity to the airport to determine if the airport had any impact on the urban land values over periods of time. The result of this model will fulfill the first and second research questions. The second method will use stepwise multivariate urban land value model to examine during which periods of time the development of the airport had impact on the urban land value. It will also determine what exogenous factors are reflected in the price of land over the time periods. The results of this model will fulfill

the third and fourth research questions. With the use of these two models, urban land use in the study will be classified into six types of land use: agriculture, commercial, low-density residential, high-density residential, manufacturing and warehouse, and vacant land use. Moreover, the study area will be divided into four quadrants - northwest, northeast, southwest, and southeast. Then statistical methods, such as simple regression analysis and stepwise multiple regression analysis, will be used to analyze the data. Furthermore, the dissertation will use the computer software of ArcGIS in order to create land use and land value maps for the four periods of time. The GIS program will also be used to create a data set of exogenous factors to be used in stepwise multiple regression analysis. In terms of the analysis, the SPSS statistical software program will be used to analyze the data for both models.

# CHAPTER II

# URBAN LAND VALUE THEORY AND DEMAND FOR LAND USE ACTIVITIES

## Agricultural Land Use Theory

For more than a century, many economists have studied extensively the relationship between the spatial distribution of urban land use and land value in urban areas. The first theoretical framework was derived from the agricultural land use theory by David Ricardo in 1821(cited by Alonso, 1965). Ricardo's study was focused on agricultural land rent, which is determined by its fertility. That means the more productive the land, the more a tenant farmer is willing to pay for the use of land (Ricardo, 1821). Ricardo's study considered agricultural land where farmers use land of varying fertility to grow corn, and the characteristics of the local economy can be assumed as follows:

1. Fixed prices. The price of the output and input are based on the national market, which means the prices are the same at all locations.
2. Zero economic profit. All farmers make zero profit, and there is free entry to farming.
3. Fertility of land. There are three types of land: high, medium, and low fertility.
4. Land to highest bidder. Land is rented to the highest bidder.
5. Zero transportation costs. Transportation costs are assumed to be zero.

The results of the study show that competition among the farmers is based on the profit maximization which farmers can take advantage of over the product. This advantage is equal to the value of the difference in the productivity of the land. Also,

land that is located near the market tends to have lower transportation costs to ship the product to the market than more distant land. Therefore, the landlords take advantages in the form of rent as a result of the competition among the farmers (Alonso, 1965).

**Von Thunen's Agricultural Land Use Theory**

In 1826, Johann Heinrich Von Thunen developed the theory of the location rent from Ricardo's study. His study was primarily focused on analyzing the pattern of land use and land value in agricultural areas by using the concept of economic rent to explain the distribution of the various agricultural land uses around the market, which later was known as "location rent" (Cadwallader, 1996). He explained that the rent for each type of the crop can bid for the land at each location, and the land is assigned to the higher bidder in each case. That means the farmers that grow a particular product prefer to locate closer to the city, as their profit will be maximized. Also, the rent each crop can bid is also concerned with transportation cost of its product. The land that is located close to the market will save in transportation cost. On the other hand, the land that is located at a greater distance will offer no saving in transportation cost, and the rent of the land will be less as the distance increases (Cadwallader, 1996).

Since von Thunen's agricultural land use theory was created before industrialization and highway development, the assumption that underlies his theory is based on a set of simple assumptions:

1. Isolated State. It is assumed that there is an agricultural area isolated from all others. Also, the city has only one market, which is centrally located. All products should be produced within the region, and no outside product is imported to the market.

2. Uniform Plain. It is assumed that in this isolated state, all soil fertility, rainfall, and other environmental factors are the same everywhere. As a consequence, the yield per unit area for any particular crop and the production costs are the same for all farmers.
3. Transportation Costs. It is assumed that transportation is equal in all directions throughout the city, and the costs of transport are proportional to the distance.
4. Maximize Profits. It is assumed that all farmers act to maximize profit with complete information and perfect decision making abilities.

**Agricultural Location Rent**

According to von Thunen's model, the location rent had been used to represent the distribution of land use in his study. Cadwallader (1996) discusses von Thunen's location rent theory by explaining that the location rent is the total revenue received by the farmer for a particular crop on a particular parcel of land minus with the production and transportation costs of the same product and same parcel of land. Therefore, the location rent can be calculated by following equation:

$$LR = Y * (P\text{-}Cp) - Y * (Ct * d)$$

where *LR* is the location rent per unit of land ( $/acre); *Y* is the yield per unit (ton/acre); *P* is market price per unit of product ($/ton); *Cp* is the production cost per unit of product ($/ton); *Ct* is the transportation cost per unit of commodity per unit of distance ($/ton/miles); and *d* is the distance from market (miles).

According to the four initial assumptions, there are two variables contained in this equation, which are the location rent and the distance to the market. Other variables in this equation are constants and correspond to the set of simplifying assumptions that

assume the physical environment of land, the yield per unit of land, and the production cost per unit of product will be the same everywhere (Cadwallader, 1996).

**Agricultural Bid Rent Curve**

In terms of economics, the gap between the revenue and the cost is known as economic rent, and this rent will be paid to the landlord. In this sense, the relationship between location and rent and distance from the market can be expressed as a line, which can be called *a bid rent curve* (Figure II.1). It can be concluded that the farmer prefers to bid in high amount for the land close to the market, as the land generates the large profit. However, the farmer will bid less for the land that is farther away from the market, as the land generates a small profit (cited by Cadwallader, 1996).

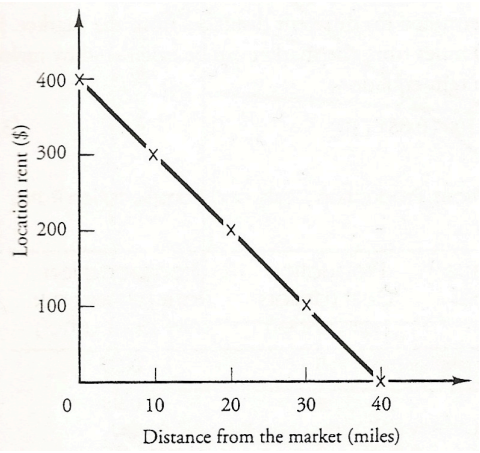



**Figure II.1: Relationship between location rent and distance from the market (Source from Cadwallader, 1996, p. 43)**

However, if the market price of a particular crop drops to some lower value, a new bid rent curve would correspond with the new lower value rather than the previous one. Therefore, the new location rent would be decreased everywhere as well. That means these new bid rent curves will represent the indifference curves, which indicate the

farmer's profit is indifferent anywhere along the line of new curve (cited by Alonso, 1964).

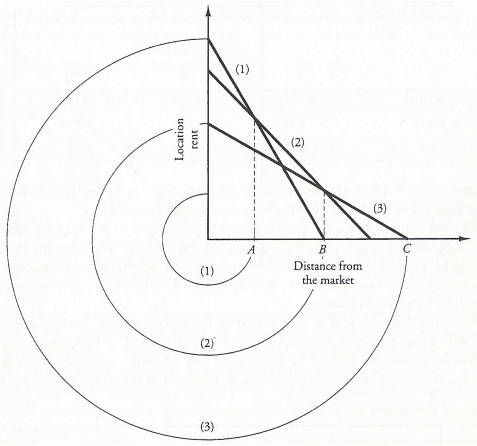



**Figure II.2. Bid rent curve for wheat (1), barley (2), and oats (3), (Source from Cadwallader, 1996, p.45)**

Von Thunen explained the situation where there is more than one particular crop that competes for the location, such as wheat, barley, and oats (Figure II.2). The assumption of this situation is that the overall supply and demand quantities are in balance and constant (cited by Alonso, 1964). According to Figure II.2, wheat farmer can pay a higher rent for the land than barley and oat farmers. Since the land can be devoted to the higher bidder, the land that is between the market and distance *A*, which is represented by the intersection between wheat and barley bid rent curve, will be used for wheat. In addition, the land between distance *A* and *B* will be used for barley, while the farthest land between distance *B* and *C* will be used for oats. It can be concluded that, with the different value of the revenue and production costs, the location rent for each crop can be determined with the difference of the distances from the market (CadWallader, 1996). This ranking of the pattern of the land use for each crop leads to a

series of concentric land use zones, which are outward from the market (Boyce, 1974).

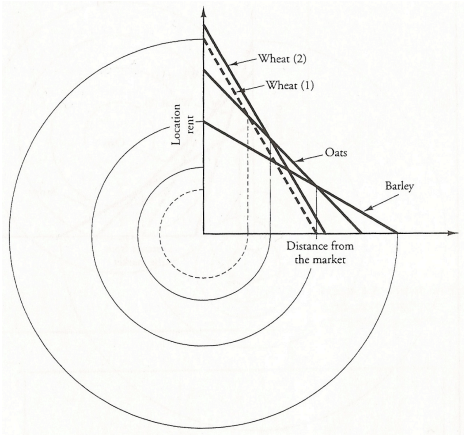



**Figure II.3: Land use pattern resulting from the change in the market price of wheat**

**(Source from Cadwallader, 1996, p.47)**

Cadwallader (1996) noted an interesting point to determine how the bid rent curve will change if the constants in the location rent equation are interfered with by any other sources, such as government policy, increase in the market price, and so on. Therefore, the new bid rent curve would be shifted to the left or right from its previous position as the land use pattern adjusts to the new location (Figure II.3). In addition, if the transportation costs of a particular product increase, the result of the new bid rent curve will have a different slope (Figure II.4), which is not parallel to the previous one. This change in slope is not the same as the previous change in slope of Figure II.3 because the effect of a change in transportation costs varied, depending on the distance from the market. The location further away from the market will have more effect rather than the location closer to the market.

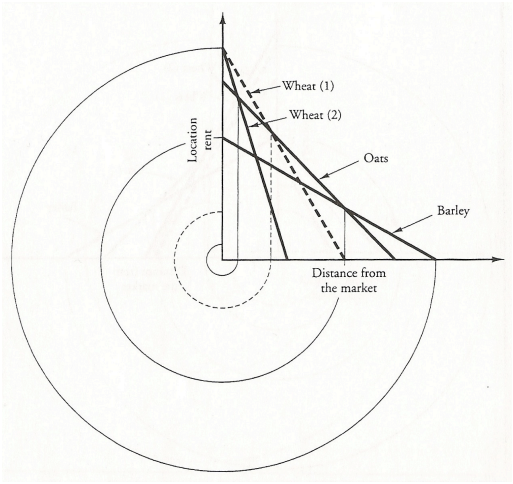



**Figure II.4: Land use pattern resulting from the change in transportation costs of wheat (Source from Cadwallader, 1996, p.48)**

## Urban Land Use Theory

### Development of Urban Land Use Theory

Most economists in the early 19th century rarely talked about location rent in the context of urban land except Alfred Marshall (1890). On occasion he discussed urban land value, which concerns profit-making land use, such as retail stores and manufacturing plants (cited by Alonso, 1964). He described the importance of the location within the city and defined the "situation value" as the sum of the money value of the situation advantages of a site. He explained that the site value, which is the price of a site that would be sold with the buildings in the free market, would be equal to the situation value plus agricultural rent (cited by Alonso, 1964). In addition, Marshall considered the relationship between the size of the site and the height of the building:

"…..if the land is cheap he [entrepreneur] will take much of it; if it is dear, he will

take less and build high….."(Marshall, 1890: cited by Alonso, 1964, p.4).

Finally, Marshall concluded that the demand for manufacturing plants would be in all respects parallel to agriculture. That means the potential of the land user to bid on the land in urban areas should be the same as in the agricultural case, while the advantage of the location is related to the decision- making of the bidders. Although Marshall's analysis provides an interesting point for the present day theory, it does not apply to the land value for residences (cited by Alonso, 1964).

In 1926, Robert M. Haig developed the concept of urban land value related to the principle of land economics. His analysis is not different from Marshall's study. However, he considered the accessibility as another factor that affects the decision–making of bidders because of the saving in transportation costs. He explained that transportation is the device to overcome the "friction of space" (Alonso, 1964, p.6). In other words, the better the transportation, the less the friction. At this point, the location rents and transportation costs determine the cost of what friction still remains, which is called " costs of friction" (cited by Alonso, 1964, p.7). Therefore, the perfect site for land use activity depends upon the desired degree of accessibility at the lowest costs of friction (Alonso, 1964). In addition, Haig considered the residential land in terms of how residents choose where to live. He concluded that residents choose where to live dependent upon the accessibility to the location to buy clothes or food, while the minimizing of the costs of friction is involved with the site rent, time value, and transportation costs (cited by Alonso, 1964).

**Alonso's Urban Land Use Theory**

Later in 1964, von Thunen's agricultural land rent theory was applied to the urban land use context by William Alonso. Similarly to von Thunen's model, Alonso's bid rent theory seeks to determine the location for urban activities based on profit maximization. All urban spaces are occupied by the activities that pay the highest rent and represent the best use of the land. In terms of retail activities, several hypotheses have been proposed about the bid rent theory and the optimal relationships between store types, sizes, rents, sales, and distances from the market center. Since the city center is the most accessible location because of adequate of transportation systems, it offers the maximum market potential and optimum access to sources of labor and consumer. As a result, the most desirable location will go to the highest bidders. Furthermore, the highest rent is charged for land within the city center, and the rents decline the further the distance from the city center (Brown, 1992). In addition, Alonso used the same context of agricultural land rent and generated a series of land use zones from the intersection of different bid rent curves, along with a set of simplifying assumptions. (Alonso, 1964). The simplifying assumptions for Alonso's urban land use theory are:

1. One center. It is assumed that the city has only one center and central business district. All the employment opportunities and shopping centers are located in the central business district.
2. Featureless Plain. It is assumed that all sites within the city are the same everywhere. That means no sites within the city have advantage or disadvantage associated with geology.

3. Transportation Costs. It is assumed that the transportation is equal in all direction throughout the city, and the costs of transport are proportional to the distance.
4. Highest bidder. It is assumed that each plot of land is usually sold to the highest bidder, while all land users have equal opportunities to access the land with no interference from the market economy and government policies.

Alonso's bid rent curve associated with land use pattern can be analyzed within the three major types of urban land use - retailing, industrial, and residential (Figure II.5).

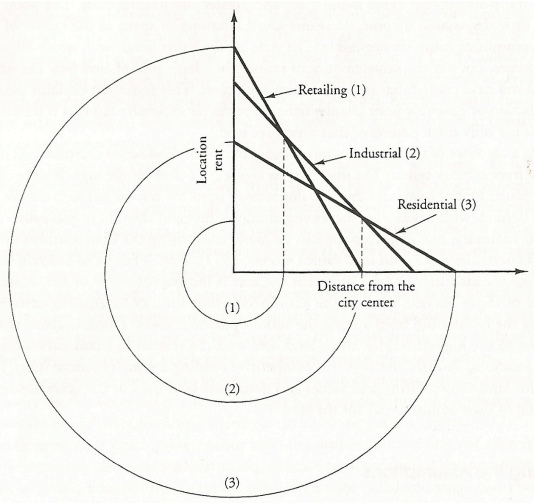



**Figure II.5: Alonso's Bid Rent Curve for Retailing, Industrial, and Residential (Source from Cadwallader, 1996, p.53)**

According to Figure II.5, the steepest slope of the bid rent curve represents the retail activities, including retail and wholesale, office, financial, and manufacturing, which is the most sensitive to the accessibility and also concerned with the higher rate of turnover in the core area. Alonso argues that the firms trade off between land costs and sales. In addition, they choose locations that maximize profit. A bid rent curve for an

urban firm can be defined as the profit that will be deducted from the operating costs and land costs. The location rent of retailing will decline with the increase of the distance from the central business district, which also decreases accessibility and potential profits (Alonso, 1964). Similar to the agricultural bid rent curve, individual retailers are indifferent to the location along the line, where the profits will be the same everywhere. The profits will be high when moving toward to the center of the city. Therefore, the retailers can afford to bid for the use of land that is close to the central business district.

Moreover, the bid rent curve for industry decreases with the increasing distance from the center of the city, similar to the retailing bid rent curve, but the slope of the bid rent curve is not as steep for retailing. That is because industry does not consider the accessibility as retailing does. Alonso (1964) explained that many industrial products are usually sold outside the city, which also reduces the importance of the location within the city.

In addition, the bid rent curve for residential land use is the shallowest among the three types of land use. Alonso argues further that households determine their residential locations based on the trade-off between the costs of commuting and land costs, and residents choose their residential locations in order to maximize utilities. A household is different from an urban firm and agricultural land because satisfaction is taken into the account instead of profits. The bid rent curve of the household will be equal to satisfaction in every location. Along with the bid rent curve, the price of the land will decrease with the distance from the center because of the advantage of cheaper land located further away from the center. By increasing the distance from the CBD, the household can find more space for living. In comparison with the retailing bid rent curve,

it is unlikely that the residential land use is able to outbid retailing because competition in the urban land market in the city center requires greater capital investment and more profit in return. Therefore, residential areas located toward the center of the city are usually characterized by high-density in order to obtain the satisfactory return on investment for residential developers (Alonso, 1964).

In addition, in terms of agricultural land use and urban firms, Alonso points out that the profit a farmer can make depends on the distance from his land to a market. That means, if a farmer produces a crop at the market, then the benefit he makes should be equal to the sell price ($) – costs of production ($). However, if a farmer produces a crop at some distance, then the benefit he makes should be equal to the sell price ($) – cost of production ($) – transport cost ($). Therefore, the farmer will receive lower profits or operate at a loss if he produces his crop farther away from the market. Moreover, if the demand for the crop increases, the price of the product will increase also. As a result, the farmer will make more profits because the costs of transportation and production remain the same (Alonso, 1964).

Furthermore, the farmer has to pay the rent to the landowner for the land, depending on the profitability of the location. That means the profits that the farmer makes will be shared with the landowner through the rent. Farmers bid for the more profitable locations so that all the farmers can make profit, and then the profits that have been made will become rent (Alonso, 1964). For example, if one crop can make more profit than another because of closer distance to the market, then the farmer who produces the first crop can bid higher rents for the profitable location. However, if the location is far away from the market and the second product can make more profit than

the first, then the second farmer will be able to bid higher rents for the more profitable location (Alonso, 1964).

Moreover, transportation costs and travel time also affect the satisfaction of people who live far away from the center. Alonso points out that poor people usually live close to the center, and wealthy people live on the periphery. While poor people with lower income prefer to buy a small piece of land near the city center, they also save money on transportation costs to work in the city. On the other hand, more affluent people can pay the same amount of money to buy a larger piece of land at the edge of the city and still have enough left to cover transportation costs (Alonso, 1960, 1964).

Ratcliff (1949) argued that the spatial organization of every land use activity is the product of economic forces throughout the entire urban area. Therefore, the pattern of urban retailing should be distributed by bid rent functions, such as department stores and specialty shops, in the city center and lower order activities, such as grocery stores, in the urban fringe. Following Ratcliff's idea, Scott (1970) argued that, especially in the city center where the competition for space is high, some specialty shops that require more intensive land use may outbid other retail activities. For example, both jewelry and furniture stores sell small products of high unit value and require little space for display. Therefore, the jewelry stores should be able to outbid furniture stores for a central location based on the differential rent-paying abilities of the stores (Brown, 1992).

Similarly, Garner (1966) applied bid rent theory to explain the internal structure of retail nucleation outside the city center. Garner assumed that most higher order retail stores are willing to pay more rent for the central locations than lower order retail stores. He explained that in small neighborhoods the central location is usually occupied by the

convenience trades, and the lower order shops in the retail hierarchy are pushed into the periphery since high order retail shops can outbid lower order shops. Therefore, the core areas include department stores, apparel retailers, and jewelry stores, while the periphery would consist of business like hairdressers, laundry, and hardware stores. Between these two areas, there are some retail activities, such as cinemas, banks, camera shops, and insurance agencies.

Despite the lack of reliable and comparable data on land values in the past, most of the available information is usually associated with the bid rent model, including the study of Chicago (Yeate, 1965), St. Louis (Wieand and Muth, 1972), and Sendai City, Japan (Sasaki, 1991). These studies revealed a remarkable result in terms of declining urban land values as the distance from the city center increases.

## Demand for Land Use Activities

Certain forces give rise to the growth of cities, and for airport cities one of these forces is the demand for urban land for different types of land use. Since the impact of an airport on economic development land use pattern is significant, location theories can be used to describe how people choose where to live, how firms and retail businesses choose where to locate, and how manufacturers choose where to site their plants. However, it is very useful to understand the demand for service of urban land before determining how those urban activities choose their location. The discussion of the demand for service of urban land generally is based on the urban economy and the factors that influence the extension of the urban activities.

**Demand for Housing**

Without doubt, most of the developed areas of cities are devoted to residential use rather than to other types of land use. Therefore, the demand for housing can be considered a higher priority than other types of land use. Two points of demand for housing cannot be overlooked: first, the number of dwelling units, and second, the quality of dwelling unit (Ratcliff, 1971). Ratcliff described the number of dwelling units as the housing space that supplied the full complement of living facilities and quality of dwelling unit as quality of housing related to physical and economic characteristics, such as its size, equipment, neighborhood environment, type of enclosing structure, price or rent, and tenure (Ratcliff, 971)

He pointed out that, in terms of quality of housing, by increasing the population in the community by such means as migration, birth and growth rate, marriage, or divorce may affect the demand for housing as well. If a shortage of housing occurs in the area, families may be forced to double up, share dwellings, or live outside the community because of the lack of available housing in the area.

These factors also relate to the qualitative aspects of demand. The bid rent in the market can determine the kind of housing to rent or own and also influence demand in housing. The qualitative aspects of demand can be determined by many factors, such as tenure, and are concerned with qualitative features of housing, such as type, size, style, location and price or rent. In terms of tenure, when a family seeks a place to live, whether to rent or buy, they will make their decision based on many factors, such as occupation, age, financial status, financing terms, market condition, and relative costs (Ratcliff, 1971). For example, in terms of occupation, the certainty or uncertainty in employment

influences the decision the decision to either rent or own a property. If an occupation is insecure for any reason, this family may decide to rent housing rather than buy it. In terms of location, many people generally prefer to live in neighborhoods where there are people of the same social and economic class. Similarly, the convenience, relating to distance and transportation facilities (time and cost) is another factor when people choose where to live. Some families prefer to live in a location convenient to their work.

Finally, in terms of the cost of buying or renting, with a limited income, some families will consider purchasing a house based on the total expenditure for housing, including housing value and additional purchasing price. If some item is required for additional costs for greater utility rather than comfort or pleasure, then the family may not spend money on the house. In addition, usually families with similar income tend to occupy similar units in the same class of housing (Ratcliff, 1971).

**Demand for Nonresidential Space**

Demand for nonresident space usually deals with commercial, industrial, recreational, and public service activities. The demand for retail space is founded on the expectation of the economic return in terms of profits. The competition in the retail market leads various types of retail stores to focus on location for their own operations. Thus, competition in the market may affect the distribution pattern of the retail store locations in an urban area (Ratcliff, 1971).

Ratcliff also mentioned that many factors influence the amount of space required by retail services. The ratio of the land use to the city size by population is one factor that should not be overlooked. In other words, the ratio between city size and population tends to be lower where the population density increases. Therefore, the density of population

is one factor in determining the demand for retail space. In addition, there is a tendency for the ratio of the retail space to population to increase as the distance to the CBD increases as well. Moreover, the social and economic characteristics of population are another factor. For example, the higher the income of the people in the community, the greater the demand for retail services. If people in the community have higher income, they tend to prefer a variety of products. Therefore, the demand for retail services in an area should increase dramatically to support the needs of community (Ratcliff, 1971).

In addition, Ratcliff pointed out that the ratio of office space requirements to population might vary, depending on the economic characteristics of the city. For example, communities that are predominantly industrial tend to have lower office space-ratio than those with substantial financial uses. However, he noted that it cannot be expected that the population will also increase in proportion to the demand for office space.

In contrast, he argued that the location for office space might not be as important as for retail space. The significant factors for choosing office space depend on the physical characteristics of the space as well as the services provided by the landlord, such as the attractiveness of the building, the quality of elevator service, and the layout of space (Ratcliff, 1971).

Convenience for customers and employees is another important factor for choosing office space location. Offices that serve customers should be located in areas that are accessible to transportation facilities. Similarly, offices space should be located in locations that are convenient for employees to get to and from work. In some cases,

similar types of businesses are grouped together in the same building to provide convenience for customers and facilitate shopping among the businesses.

**Demand for Industrial Space**

Finally, Ratcliff stated that the proportion of urban area devoted to industrial uses might vary, depending on the city, where there may be some demand for industrial space. The space requirement for manufacturing can be determined by the number of establishments and the nature of operations. For example, in a city where steelmaking and processing plants are located, the ratio of the industrial area will be higher than in a city of equal size where jewelry manufacturing is located.

According to Ratcliff, several factors affect the change in demand for industrial space. In terms of increasing demand, the factors include: the expansion of existing industries, the establishment of new industries, and immigration. In contrast, decreasing demand for industrial space may result from reduced production, emigration, and changes in technology that require less area for processing the product. The increasing and decreasing of the demand for industrial space is also associated with the rise and fall of business activities in the city. That is the result of the increasing or decreasing of the population in the city. When population increases, the demand for industrial land also increases to improve and increase production rate (Ratcliff, 1971).

# CHAPTER III

## TRANSPORTATION PLANNING AND LAND USE: AIR TRANSPOTATION AND LOCATION OF ECONOMIC ACTIVITIES

The developments of urban transportation have dominated the pattern and the form of the land use within cities. Distribution networks and accessibility of transportation have become important factors for developers in choosing appropriate locations for their businesses and plants. Many theories that are dominated by transportation have been used to describe the development of cities. One of the most famous theories is the corridor -- a theory of urban system -- proposed by C.F.J. Whebell in 1969.

### Evolution of Transportation Systems and the Impacts on Urban Structure

In 1969, the term corridor was used by Whebell to apply to a linear system of urban places with links to the modes of transportation. He claims that corridors are very persistent and form different types of urban systems. The impacts of the corridor on the urban system are significant in term of the growth of the city centers and the success of the economic development of cities. In his theory, Whebell (1969) divided the development of corridor-centered economic landscape into five stages: subsistence agriculture, commercial exchange, rail transport dominance, the early automobile period, and rapid transit and metropolitanism. His analysis of each stage represents the diagnostic innovation of changes in economic system and outward diffusion in a sequential urban pattern. To illustrate the spatial development of the corridor system, a series of five maps of new world landscape was prepared based on three variables: coastal configuration, natural drainage, and zone of differing land quality. The

desirability of land in the early period of settlement was based on land quality that was described as a land use hazard.

First stage, *subsistence agriculture*, is the period of the perception of land quality and the development of urban space along main routes of access, generally along the river valley of a natural drainage line. The settlement is usually located along those routes of natural landscape. *Commercial exchange* is the second stage, which increases the amount and intensity of land settlement in order to respond to the increasing quality of agricultural and commodities that create the demand for transport. *Railway transport dominance* is the stage concerned with the lower cost of transportation, which encourages the entrepreneurs to invest in railways. The most successful lines are those joining with developed towns where railway services can connect and serve the manufacturing industries located in the core areas. The next stage, *the early automobile period,* is the period during which the cities are dominated by road systems rather than railway systems. The increasing use of the automobile is significant in this period and has a direct impact on the economic development of the town. That means the economic system of towns, such as wholesaling, retailing, and services, are dominated by the road system, which connects the important towns and leads to an explosion in urbanism in terms of increasing recreational land use.

The final stage is *rapid transit and metropolitanism.* Since the motorway has an influence on metropolitan places and on the entire landscape system, the different modes of transportation, such as highway development and rapid transit, also exist essentially for the convenience of the inhabitants and businessmen to travel to the core area. Furthermore, the motorway or high speedway also affects wholesaling, retailing, and

services by attracting businesses to locate close to these corridors and by increasing the accessibility of the businesses (Whebell, 1969).

### Aviation: An Alternative Mode of Transportation for the 21st Century

Air transportation has come to dominate other modes of transportation in the 21st century. More than a billion people each year travel through airports. Decreasing costs of airline travel, competition of airline companies, and the advantages of faster travel time are some of the factors that have given people more opportunities to travel by air than by other modes of transportation. The increasing numbers of passengers and commodity shipments have become logistics. Therefore, the distribution of products will be widespread throughout the world. The success of businesses will rely not only on the continual improvement of product quality, but also on fast response to distribute these products to customers around the world (Kasarda, 1999).

Since speed and agility have become more important for some types of products to ship to the markets outside the region, the accelerated development cycles, flexible production, and quick response will make time-based competition more significant (Kasarda, 1999). That means firms that are most successful in time-based competition usually use advanced information technology and high-speed transportation to respond to the needs of customers around the world. Therefore, the shift to the global economy will also generate the expansion of market opportunities. Kasarda explains,

> Firms will find international partners and rely on just-in-time suppliers and sophisticated downstream logistics providers to combine information between supplier and customer with production flexibility. Manufacturers will customize or differentiate products to create customer value, and also be able to offer the same speed and flexibility in delivery process-from the time their assembled products leave the factory until the time they arrive on the customer's doorstep (Kasarda, 1999, p.25).

Flores-Fillol and Nicolini (2006) quote Steve Lueck, AMB vice president and asset manager, as follows:

> You can have the best product and the best marketing, but if you can't get your product to the user through the supply chain efficiently, you will lose…. Logistics are valuable in the supply chain, providing more than a way to move a box from here to there" (cited from Flores-Fillol and Nicolini, 2006, p.1).

Since the concept of just-in-time production is the new trend that dominates the global market competition, it is clear that the air freight industry will play an important role in this coming economic era. In addition, Kasarda (1999) argues that air commerce will have significant impacts on the urban economy and land use because of the revolution of global supply chain management and industrial location decisions. That means firms have found that they can reduce the number of factories and warehouses through air cargo logistics while improving overall performance (Kasarda, 1999, p. 27). He continues:

> Air commerce is likewise creation entirely new industries as shipping customized clothing and freshly-cut flowers to distant markets within hours, adding considerable value to products. People not only pay for freshness in perishable goods, they also pay extra for the satisfaction of speedy, reliable delivery of more durable goods (Kasarda, 1999, p.26).

As a result, the concept of just-in-time becomes a big player for international competition. The adoption of the just-in-time system causes some manufacturers to relocate their distribution centers close to air transportation facilities in order to provide fast delivery to their customers around the world. Kasarda claimed that international air cargos would increase dramatically, by at least 6.5 percent annually, during the 1990s (Kasarda, 1999). The results of the competitive advantage through air logistics, therefore, will lead to increased value of land around the airport and the agglomeration of

industrial and commercial development in these new economic development areas (Kasarda, 1999).

## The Development of the Aerotropolis

Kasarda (2000) proposed the term "aerotropolis," which is characterized by a high concentration of commercial activities, some cargoes, and industrial uses around airports. The gathering and clustering of different types of development in terms of residential, commercial, and industrial uses have led cities to expand outward toward and around airport areas, which assumes the airport itself as a new kind of Central Business District, or "aerotropolis."

Kasarda (2000) also defined the functions of the aerotropolis, and the passenger terminal can be referred to as the core function. The aerotropolis itself should be operated as a multimodal commercial nexus offering varieties of goods and services, such as offices, hotels, and exhibition complexes. The clustering of the businesses will usually occur around the airport and airport corridors (Kasarda, 2010).

Likewise, airports are similar to many major transportation interchanges that have impact on the land use pattern. Their impacts also cause changes in land use patterns as cities continue to expand outward and sometime around the airports (Kasarda, 2010). Kasarda also determined that the growth of the airport area is shaped by many factors, such as (1) firms that provide air transportation services, (2) firms that are frequent consumers of air transportation, (3) businesses that cater to the ancillary needs of air travelers and employees of the previous two types of firms, and (4) companies that may simply be searching for accommodating sites with good regional highway access. These factors create new directions of land use patterns, which are associated with the influence

of airports on the land use activities. Since the importance of air transportation and airport cities is increasing, planners have focused intensively on the new model of the airport city to prepare and provide better policies for this new urban form of the aerotropolis. As a result, this new model of aerotropolis has been used worldwide for planning in places such as Hong Kong, Incheon, Kuala Lumpur, and Dubai.

For example, as Kasarda points out, in the Hong Kong International Airport, which opened in 1998, the main terminal hosts a galleria (The Atrium) with more than 20 high-end designer clothing shops. The airport also includes the world's largest terminal commercial lounge, which includes a 15,000 sq. ft. full-service business center and for overnight stay the Regal Airport Hotel, which connects terminals 1 and 2. Similarly, the Singapore International Airport has provided new facilities, such as cinemas and fitness centers, while Amsterdam Airport Schiphol also provides a casino and art gallery. Likewise, Incheon International Airport in Seoul is also developing large commercial tracts around the airport, called Air City, which consists of office buildings, hotels, a golf driving range, a water park, a global medical center, and Disney-scale theme park with casino hotels. Also, Air City has planned for further development of offices, hotels, shopping, and convention facilities on a large piece of land near the passenger terminal. A Maglev train system will connect the terminal with all Air City commercial activities.

With the airport area serving as a region-wide multimodal transportation and commercial nexus, clusters of airport-oriented hotels, convention centers, trade and exhibition facilities, office parks, information and communications technology complexes, recreation and entertainment venues, facilities for time-sensitive goods handling, and mixed-use residential/commercial developments are forming along airport

corridors up to 30 kilometers (18.64 mile) outward. Because of excellent airport corridor accessibility, as well as highway and rapid transit systems, these clusters of businesses serve not only air passengers, but also local residents. Therefore, the aerotropolis that develops around airports and airport corridors will significantly affect the pattern of land use in the 21st century (Kasarda, 2010).

## Urban Economic and Land Use Impacts of Airports

With the rise of global economic competition, speed, mobility, global access, and air transportation have become major factors that impact the economies of the cities and the pattern of the land use around the airports. The logistics functions, such as kitting, packaging, labeling, and supply chain sequencing have impacted the firms to choose locations for their facilities closer to the airport (Kasada and Appold, 2006).

Kasarda and Appold claim that many jobs around airports have been attracted to airport development areas within 2.5 miles of the airport, and it is sufficient for airports to populate an entire metropolitan area on their own and employment sometimes increase to a quarter of a million. They argue that some airports may be located closer to a central business district within a five-mile radius and will result in an increase in number of employees (Kasarda and Appold, 2006). In the case of Dallas-Fort Worth Airport, for example, more than 400,000 jobs have been attracted to the airport area within a five-mile radius. Over 200,000 jobs have been created within five miles from Dulles International Airport, Washington D.C. Moreover, Detroit's Metro Wayne County Airport created more than 90,000 jobs within five-mile radius, and Denver International Airport created 72,000 jobs within that distance (Kasarda and Applod, 2006).

Manufacturing, air cargo, warehouse, and wholesale trade are attracted to the airport area for some types of products. Flores-Fillol and Nicolini (2006) claim that there is a high concentration of industrial parks and warehouses located within a 10 mile radius, with less concentration when the distance moves outward. For example, the concentration of the industrial park appears to be high around the Madrid-Bajaras Airport in Spain within a 10-mile radius of the airport. Similarly, with the expansion of the Koln-Bonn Airport in Germany to over 450,000 sq m, a large number of industrial parks surround it within 10 miles and a fewer number of industrial parks with the greater distance from the airport (Flores-Fillol and Nicolini, 2006).

For accommodations and food services, Kasarda and Appold (2006) claim that there is a high concentration of businesses close to major airports and airport corridors. For example, a number of hotels are concentrated around Los Angeles International Airport. Similarly, at Atlanta's airport about 50 hotels are concentrated within 2.5 miles of the airport. Moreover, within the Las Vegas international airport area, some casino hotels are located around the airport, even about 1,000 feet away from the airport fence.

It is clear that the prestige of the airport development area has high potential to attract businesses to the area because of the high accessibility to transportation infrastructure. It is possible that, since the airport development areas can attract the businesses to the surrounding area, airport-centered development represents no difference from the development of central cities (Kasarda, and Appold, 2006).

**Classification of the Economic Activities At and Around Airports**

In 1993, Weisbrod, Reed, and Neuwirth studied the economic impacts and planning for development around new or expanded airports to identify the nature of

economic activities occurring in the airport areas, the factors affecting their magnitude, and applications of the model system for airport-related planning. In their study, they separate the business activities that occur around the airport and in the metropolitan area into two categories: (1) *new activities* and (2*) expansion of existing business activities in the metropolitan area* (Weisbrod, Reed, and Neuwirth, 1993).

*New activities* may be attracted from outside the airport area. There is evidence that the prestige of the area and increasing accessibility to air transportation and local transportation facilities also affect the uses of land around the airport area. Since a large commercial airport or international airport affects the economy of the entire region, the new activities may include: regional or national corporate headquarters, trade and merchandise centers marketing retail or industrial products, service companies dependent on air service to reach their market, and airline and related activities. Examples of these types of business are membership organization headquarters near Washington/Dulles airport, as well as exporters in the Amsterdam and Paris international airports. Furthermore, the airport affects not only the changes around the airport, but also the changes in economic activity in the entire metropolitan area (Weisbrod, Reed, and Neuwirth, 1993).

In addition, *expansion of activities in the metropolitan area* may occur for many types of businesses, such as users of airport services, suppliers to markets generated by the airport, or businesses that can take advantage of the local transport and other supporting infrastructure developed to serve the airport. These types of activities include high technology electronic equipment manufacturers, communication companies, warehouses and delivery services, and varieties of specialized business services

(Weisbrod and Reed, 1993). They also explain the expansion of the rapidly growing hotel and convention facilities in the airport areas. Surprisingly, the results of their case studies indicate that the passenger volume of an airport is not the main factor in the expansion of these activities. Instead, they found that the prediction of the number of hotel rooms is based on four factors: extent of hub versus destination travel, airport location relative to office activity centers, hotel agglomeration at conference centers, and land use restrictions (Weisbrod, Reed, and Neuwirth, 1993).

Similarly to Weisbrod, Reed, and Neuwirth's study, in 2001 Mathis Guller and Michael Guller divided the aeronautical and non-aeronautical activities around airports into three different categories related to air traffic volume:

> (1) core aeronautical activities, which are the part of technical operation of the airport, and directly supporting the air traffic function; (2) airport-related activities, which have a direct relation to air-freight or air-passenger movements (e.g., logistics and distribution activities or terminal retail and hotels); (3) airport-oriented activities. This type of activity chooses the airport area because of the image of the airport and its typically excellent ground accessibility. The price of land and surface connectivity are the key factors in determining those activities located in the airport area (cited by Kasarda and Appold, 2010, p.12).

**Factors Affecting Attractiveness of Airports for Businesses**

In light of the increasing number of business anchors around airport development areas, there are three factors that affect the attractiveness of an airport for businesses. These factors, which were identified by Weisbrod, Reed, and Neuwirth in 1993, include *airport market orientation*, *transportation access*, and *urban land development pattern*.

In terms of *airport market orientation*, Weisbrod, Reed, and Neuwirth (1993) explain that the mix of airport activities, such as transfer hub versus origin/destination traffic, passengers versus freight, and destination, can affect the nature of business attraction and land development. In reference to the hub airport, for example, it is clear

that there are many transfer passengers compared to destination passengers. This can affect the increasing employment at the airport. Another example concerns freight activity, which is greatest for airports with international and long-distance services. For a city with a second airport, the newer airport usually takes nearly all of the freight activities. In addition, warehousing and distribution facilities are concentrated where the cargo freight traffic is located. Since international airports affect the global economy, there may be a high concentration of cargo centers with adjacent activities, such as freight transshipment, logistics management, and distribution tracking control facilities.

In addition, the pace and scale of business attraction in the vicinity of an airport is defined by both the local pattern of ground transport and the land development pattern. In term of *transportation access and land development patterns*, Weisbrod, Reed, and Neuwirth explain that, with the lack of accessibility and land development, an airport might not attract the anticipated level of business activity. For example, business attraction to the vicinity of the airport might be limited by long travel time or distance from the existing office and commercial area to the airport, or by the growth of the urban area in a different direction from the airport.

Some case studies show the impact of the lack of accessibility and land development. For example, the development around the Roissy/Charles de Gaulle Airport in Paris was very slow and did not attract new business activities in the first 18 years. This was due to the long distance between the existing commercial center and the airport, which is located in a lower prestige side of the Paris metropolitan area. Similarly, although the Mirabel Airport in Montreal provided a lot of land for development, the airport could not attract the anticipated business activities in its first two decades of

operation. The model was used to estimate level of business activity and employment at the airport, adjacent to it, and within a 6 km. (3.78 mile) vicinity of airport. However the results of the model suggest that the airport may have impacts on the rest of the metropolitan area.

## Some Case Studies on the Impact of the Airports on the Urban Economic Development and Land Use Patterns

Many empirical studies have been conducted on the impact of the airports on urban economic development and land use patterns. Studies focusing on economic activities and economic development impacts around the airports have been conducted by researchers, such as Weisbrod, Reed, and Neuwirth (1993); Hakfoort, Poot, and Rietveld (2001); Brueckner (2003); Green, (2006); and Kasada (2010, 2009, 2006, 2001, 1999).

### The Effects of an Airport on Land Values

The relationship between an airport and land values is rarely examined in the study of urban land economics. In fact, not much of the literature studies the effect of an airport on land values.

In 1973, Ronald W. Crowley conducted a study that is concerned with the effect of airports on land values. This study examines changes in land value in the vicinity of Toronto International Airport to determine changes in the mix of residential, commercial, and industrial uses. Crowley explains that two tendencies affect the residential and commercial uses relative to the positive and negative influence of airports on land value. First, there are developments of residential and commercial uses in the area adjacent to the airport because of the increasing in demand for the particular real estate. Second, on the other hand, affected residents tend to move in the opposite direction from airport

expansion because of noise pollution, regulation controls for runway used, and landing and take off schedules (Crowley, 1973). Moreover, J.F. Gautrin (1971) noted that "if noise were eliminated, the agents thought prices of house would increase on average 10 percent (5.5 percent, 9.5 percent, and 14.5 percent for low, medium, and high price housing respectively)" (cited by Crowley, 1973, p.145).

In the analysis, Crowley assumes that, if an individual home owner considered in the environment of the airport, any development at the airport resulting in an external diseconomy might have two side effects; (1) the external diseconomy could reduce residential property value; and (2) the effect of the external diseconomy might shift the land to a higher development rent activity, for example, from residential use to commercial or industrial use. He also claims that, if the external diseconomy exists, especially for residential uses, there might be external economies for other uses (e.g., accessibility to transport as an external economy for commercial use). Therefore, the price of land for other uses might be higher than the pre-development price. Since the airport produces air transportation as well as air and noise pollution, the external economies for commercial and industrial uses as well as external diseconomies for residential use can be anticipated (Crowley, 1973).

The results of the study show that there is a significant difference in changes in the price of land in the vicinity of the airport compared with non-airport area. Also, the residential land values decrease during the period of change (expansion of the airport development area), but come back to increase in value after that as a long-term trend. In addition, the mean price of the residential land value in the airport area seems to be higher than the area that is farther away from the airport (Crowley, 1973).

**Location Rents of Airport Development Areas**

In 2004, Richard Golaszewski wrote a paper on the location rents and the experience of US airports, exploring whether airports can capture location rents from off-airport businesses that serve airport customers. He claims that "in case of airports, the location rents can apply to both on-airport activities and to area adjacent to the airport or off- airport activities" (Golaszewski, 2004, p.62).

There are two principle examples that define the existence of the location rents being charged off-airport companies to access the airport. The first is the fees that are paid by companies located off the airport, such as rental cars, parking, hotels, and ground transportation. It is clear that these off-airport firms benefit from customers who access the airport. Second, location rents of airport may be in the area of "through the fence operations" (Golaszewski, 2004, p.63). These allow companies off the airport to grant access to the airside part of the airport in return for the benefit. These firms include aircraft hangars, manufacturing enterprises, cargo facilities, and so on. Golaszewski claims that the FAA promotes the fees for off-airport firms because firms can compete with on-airport firms offering the same services. Therefore, this can protect the airport concessions from lower cost competition and is also important for charging off-airport firms for the usage of the airport facilities and services to access their customers.

Similarly to the study of Golaszewski is a study on locational and monopoly rents at the airport by Peter Forsyth (2004). His paper is concerned with the variation in the rents associated with airports and the factors that influence the rents. He claims that there are two types of rents that may exist at airports: locational rents and monopoly rents.

Locational rents are the premium costs that users are prepared to pay for preferred locations for economic activities. On the other hand, monopoly rents are costs that come through the use of the market power. The owner of the facility can raise the price of using the facility to above the cost of supply (Forsyth, 2004).

For the locational rents at airports, Forsyth (2004) classifies them into three categories: (1) at terminal, (2) airport land or land with close proximity to the main activities of the airport, and (3) land surrounding the airport or several miles away from the airport. First, at the terminal space may be limited. Since there is a number of a businesses preferred at this location, it may cause the price for rents to be higher than any other locations. Second, airport land will be limited and will command the premium. However, in most airports, there will be available land within a given distance from the main facilities. Finally, land surrounding the airport will be preferred for various types of activities related to the airport service, such as hotels, catering facilities, parking, and offices.

Forsyth (2004) concludes that locational rents will increase when moving close to the operations of the airport, and rents will decrease when moving further away from the airport. In addition, land around the airport can command locational rents, and how high the rents are depends on how restricted the land supply is, the attractiveness of the land related to the airport, and the distance to the airport. Also, locational rents can depend on how good the accessibility is. If the transportation is very good, locational rents will be valuable. On the other hand, if the transportation is very slow and expensive, a location closer to the main activities will be preferred. Therefore, the location rents in close proximity to the airport will be higher than any distance away (Forsyth, 2004).

**Airport Area Economic Development Model**

The study by Weisbrod, Reed, and Neuwirth is based on studies of airport research by Cambridge Systematic Inc., a private consulting firm that surveyed the economic activities around five airports in Europe, Japan, and North America.

Weisbrod, Reed, and Neuwirth used the survey results and developed a model to forecast the economic impact and plan for airport land area development. They considered impacts in term of airport facilities employment, directly related business activities, and businesses attracted to the surrounding area and spin-off development. Their model has been used to identify the nature of economic activities occurring in each of these areas, the variable factors affecting their magnitude, and applications of the model system for airport-related planning. Weisbrod, Reed, and Neuwirth also defined the location of business relative to airports into four categories: (1) at the airport, (2) adjacent to the airport, (3) in the vicinity of the airport or along the airport corridor, and (4) elsewhere in the metropolitan area or region. Each location has different characteristics of airport- related business and different timing of development. Therefore, these characteristics can be explained by various factors, including airport requirements, the regional economy, local transportation access, and land market (Weisbrod, Reed, and Neuwirth, 1993).

Furthermore, Weisbrod, Reed, and Neuwirth expected that employment at the airport associated with airport operations includes the airlines, aircraft support services, passenger services (restaurants, shops, and ground transport), air freight services, and government activities. They claimed that airport employment depends on the volume of aviation activities at the airport, which is determined not only by the population of the

region it serves, but also by the airport's air service function. Moreover, they expected the activities adjacent to commercial airports would include services directly supporting the operation of the airport (flight kitchen, aircraft maintenance service), service for airline employees and passengers (hotels, restaurants, car rental facilities), and airport-related freight services (shipping, freight forwarding, customs, and sometimes a foreign trade zone).

In addition, they found that there is a concentration of business activity within 6km (3.78 mile) of the airport or along airport corridors within 15 minutes of the airport. Most developments in these areas are either "spin-off industries" or "attracted businesses." The spin-off industries include gas stations, lodging and housing for airport workers, and retail businesses serving them. On the other hand, the attracted businesses are businesses that do not rely directly on the airport for their operation, but which value their location near an airport because of prestige, air services, and accessibility of location for visiting customers and employees arriving by air (Weisbrod, Reed, and Neuwirth 1993).

They also suggested that new or expanded airports might have several different types of effects on the business activity in the metropolitan area or region. Because of the improved quality of life and upgraded air service for the region, some businesses in metropolitan areas may shift away or relocate to the airport vicinity. In addition, other businesses may be attracted to locate in the metropolitan area, but not in the airport vicinity, Furthermore, some business growth occurs elsewhere in the metropolitan area as an indirect effect of regional growth in airport-related businesses, as those businesses in turn increase demand for other local goods and services supplied to them. Other business

growth occurs as an induced effect of the additional consumer spending by workers hired at airport-related business and their suppliers (Weisbrod, Reed, and Neuwirth, 1993).

Weisbrod and Reed also identified three factors - airport market orientation, transportation access, and urban land development pattern - that affect the timing, magnitude, and character of airport vicinity land development. In general, new business activities that are attracted to airport areas included both new activities and the expansion of the existing business activities in the metropolitan area, which was already discussed in the section, "Classification of the Economic Activities at and around Airport." Then Weisbrod, Reed, and Neuwirth (1993) introduced the three factors affecting the attractiveness of airports for business activities and land development: airport market orientation, transportation access, and urban land development pattern. The discussion of the three factors was already presented in the section, "Factors Affecting Attractiveness of Airports for Businesses."

The results of the model indicate that a number of the business activities and employment occur at the airport, adjacent to it, within a 6 km vicinity, and in the rest of the metropolitan region, as Weisbrod, Reed, and Neuwirth expected and described previously.

**Regional Economic Impact of Amsterdam Schiphol Airport**

Since air traffic has increased rapidly in the last several decades, the congestion has pressured airports to expand their capacities. Increased air traffic, combined with the expansion of the airport, affects not only the economic activities around the airport areas, but also the entire region on a macro-scale. Therefore, the study done by Hakfoort, Poot, and Reietveld (2001) examines the impact of Amsterdam Airport Schiphol on the

regional economy. They investigate the possible forward and backward linkages on the regional economy. While forward linkages indicate how much the region benefits from the proximity of the airport in term of location, backward linkages indicate how much suppliers to the airport benefit when the activities at the airport grow. For the rest of their study, they focus on the impact of the airport related to employment as well as on the evolution of different types of economic activities in the airport area itself. They describe the effects on both the demand side and the supply side of the economy because of the expansion of the airport. The first effect on the demand side is called a temporary effect, which relates to increased income and employment during the period when investment takes place because of construction firms and their suppliers. This type of effect includes the design of facilities, the building of additional runways, the construction of terminals, and so on.

In addition, taxation is a factor that should not be overlooked. Increased taxes, such as tax financing or higher interest rates as a result of public borrowing on the capital market, usually have a negative impact on consumption and investment in the economy around the region (Hakfoort, Poot, and Reietveld, 2001). Non-temporary effects of the expansion of the airport on the demand side include the costs of operation and maintenance of airport facilities, such as the employment involved in maintaining the facility, handling the aircraft and passengers, transporting cargo to and from terminal, and so on.

The results of the study in terms of the economic performance of the Amsterdam region show that, since the Dutch economy is based on two transport nodes - airport and seaport, the growth rate in the economy from the airport is higher than from the seaport.

Moreover, the growth of employment on the airport itself has increased during the 1990s, especially in the aircraft carrier sector. Also, the result of the study comparing the impact of the growth of aviation activities on economic development between the base line scenario and the zero growth scenario of aviation activities in specific years shows that a number of jobs, such as low-skilled manufacturing activities, drivers, security staff, and the like, are created by the actual growth of the aviation activities rather than zero growth scenario. In addition, there are different productivities between these two scenarios, particularly for the aviation industry and the construction industry. Hakfoort, Poot, and Reietveld (2001) conclude that there is a possibility that a certain part of the development in Amsterdam and the Schiphol area is the consequence of a spatial relocation of economic activities. One must not underestimate the attraction to firms that consider a new location because of the fast growth of airports (Hakfoort, Poot, and Reietveld, 2001).

**Airports and Urban Economic Development**

Similar to Hakfoort, Poot, and Reietveld's study, in 2006 Richard K. Green conducted a study of Airports and Economic Development in order to examine the relationship between airport activity and economic development based on the study by Brueckner (2003), Airline Traffic and Urban Economic Development. There is clear evidence that good airline service is an important factor in urban economic development. According to Brueckner (2003), a 10 percent increase in airline passengers will lead to a 1 percent increase in employment in service-related industries. Surprisingly, this study shows that increasing airline traffic has no effect on manufacturing and other goods-related employment. Also, there is less significance for the firms than for services – related businesses (Brueckner, 2003).

Since the number of people taking commercial flights is increasing dramatically every day, passenger traffic can have a direct impact on both business and consumption. Green uses four variables to define the impact of airline traffic on economic development: boardings per capita, originations per capita, cargo per capita, and hub status. The interpretations of the boarding per capita and originations per capita are quite difference. Boardings represent total airport activities, which have little spillover beyond the airport itself. In fact, the primary economic benefit is to create jobs at the airport although the travelers might increase job opportunities and cause a city to grow. On the other hand, the passenger originations can define how an airport creates economic activities because they show how many people are being directly delivered to an economic activity. In terms of hub status, this variable can be defined if the airport is the hub for a major carrier. Therefore, it will be useful to use this variable to examine whether bringing passenger to airport to change planes would affect the economy of the region.

Finally, the cargo per capita will be used to define the impact of airports arising from business and tourist development, while the cargo measure reflects the impact of airports arising from distribution. Other independent variables used in Green's model include tax, climate, human capital, industrial structure, and average commuting time variables. Green demonstrated a strong correlation between the presence of an airport and economic success by using boarding per capita of 83 metropolitan areas in 1990 against population growth in those areas between 1990 and 2000. In terms of boardings per capita, the results show that, increasing the boarding per capita will affect the growth of employment.

For the hub status, the results show that hub cities grow faster than non-hub cities in both population and employment. However, there is no effect of the cargo hub on the growth of the population and employment. The reason for this situation is that airports serving business travelers serve "knowledge based businesses," while those that ship cargos do not (Green, 2006). Green concludes that, by adding some businesses to the airport, this is an important impact on economic development. The policies of the airport are also important. Since the economy of the airport becomes involved with political issues, the costs and benefits of the airports may affect the concentration of the community. Therefore, decisions and policies have influence on airport economy. It is possible that the large benefit of airport economy and number of flights can determine economic success.

# CHAPTER IV

# SUVARNABHUMI INTERNATIONAL AIRPORT AND THE STUDY AREA

This chapter will discuss the historical background of the new airport in order to understand the development processes of Suvarnabhumi International Airport and why it is necessary to build a new airport rather than expand the old Don Muang International Airport. Also, this chapter will describe the characteristics of the study area surrounding the new airport to explain how urban land development has changed throughout the periods of the study.

## Historical Background of Suvarnabhumi International Airport

The Royal Thai Air Force built Don Muang International Airport, the Old Bangkok International Airport, in 1914. Don Muang was an important hub of Asia as well as of Thai Airways International prior to the opening of the New Bangkok International Airport, Suvarnbhumi International. Don Muang has two runways, three terminals. Terminals 1 and 2, the international terminal, are both located in the same building, while the domestic terminal is connected to the international terminals through a tunnel. At its peak, it served most air traffic in Thailand, and in 2005 had 80 airlines operating 160,000 flights and handling over 38,000,000 passengers and 700,000 tons of cargo. At that time it was the 18th busiest airport in the world and second in Asia by passenger volume (Airport Authority of Thailand). With passenger volume increasing over the past two decades, Don Muang had reached the capacity of 45 million passengers. Furthermore, Airport Councils International (ACI) statistics indicate that in the 12 month prior to June 2006, the total passenger trips in Asia-Pacific ranked third behind Europe

and North America. However, growth in Asia-Pacific passenger traffic was a healthy 6.5% compared to Europe's 5.4% and North America's 1.1%.

ACI's statistics also show that the air freight volume handled within all Asia-Pacific in the 12 months prior to June 2006 grew 5.4% to reach 20 million tons. This was more than in North America (17 million tons) and Europe (8.6 million tons). Separately, the International Air Transport Association forecasted that over the 2005-2009 period, the highest growth in freight volume would be in Asia-Pacific at 7.2%, compared to overall global growth of 6.3%. In light of the growth in the air transportation business and the goal of becoming Southeast Asia's regional hub, Bangkok's old international airport was clearly insufficient to expand the airport facilities, such as taxiways, terminals, and parking. Therefore, the long-term plan for preparing the New Bangkok International Airport, Suvarnabhumi International Airport, was proposed in 1960, when the government commissioned a master plan for the 1990 Bangkok Metropolis.

In 1960, the Thai government assigned Litchfield Whiting Bourne and Associates to carry out a survey and town planning exercise to prepare the Greater Bangkok Plan 1980. The report noted that, "Bangkok should have a new commercial airport at a separate location from Don Muang Airport to enhance the growth of the city." This report was in line with the Federation of American Aviation's (FAA) report in 1960, "Air System Requirement Plan and Survey for the Kingdom of Thailand," which stated, "Bangkok needs to have a second commercial airport by the year 1970" in order to support the future growth of commercial aviation.

The proposed location for this new airport was in the eastern suburbs of Bangkok in the Nong Dok Mai and Nong Bon areas and approximately 17 kilometers from the

center of Bangkok. This was due to the expansion of the city towards the east, especially with regards to eastern seaboard corridors.

In 1961, the government assigned the Ministry of Transport and Communications to conduct a study on the suitable location with regards to town planning. The Civil Aviation Office (now the Civil Aviation Department) surveyed the location and air space and then proposed that the land around Klong Ladkrabang, Klong Praves and Klong Nong Ngu Hao in Bang Phli district, Samut Prakarn province, were the most suitable for the second airport. Its 30 kilometers distance from Don Muang airport is in the international range. The Civil Aviation Department proceeded to acquire the land through appropriation and purchase, with sections of public property. A total of 8,000 acres was acquired between 1963 and 1973. However, after the unrest of 14 October 1973, the airport project became the focus of the attack, and the contract was cancelled.

In 1976, the Ministry of Transport and Communications authorized Tippetts Abbett McCarthy Stratton (TAMS), a consulting firm, to review the Second Bangkok International Airport project for construction, including site selection and a master plan. TAMS reviewed 15 sites around Bangkok and completed a survey in 1978. TAMS conclude that both Don Muang and Nong Ngu Hao were suitable sites under the basic criteria of budget for construction, traveling cost between the city and the airport, cost of land expropriation, noise level, environmental impact, and air traffic control. Then the Ministry of Transport and Communication gave the final decision to go with Nong Ngu Hao and presented the report to government.

On 20 August 1979, the cabinet revoked the order to conduct studies on the second Bangkok International Airport, and authorized the Ministry of Transport and

Communications to consider expanding Don Muang Airport as an international airport. Later, the Civil Aviation Department was instructed to prepare a report on the suitability of constructing the second Bangkok International Airport for the Cabinet's approval.

In 1983, the Ministry of Transport and Communications contracted Netherlands Airport Consultant (NACO) to conduct studies and prepare a master plan for expanding Don Muang Airport. During that time, with a change of government, the Ministry of Transport and Communications revived a plan to expand Don Muang airport. The study concluded, "Don Muang airport was capable of handling air traffic until the year 2000, and should therefore be expanded for the purpose before building a new airport." In 1986, a plan to expand Don Muang airport was approved by the government.

In 1991, the Ministry of Transport and Communications submitted a new proposal for the Second Bangkok International Airport. The proposed area of 8,000 acres was located 30 kilometers from Bangkok and had already been expropriated by the Civil Aviation Department. In 1996, the New Bangkok International Airport Company Limited, which was responsible for the implementation of the Second Bangkok International Airport project, was established. By the late 1997, there was a ceremony for starting construction on ground improvement work at the Second Bangkok International Airport. In 2000, His Majesty the King graciously bestowed on the Second Bangkok International Airport the name "Suvarnabhumi Airport." Suvarnabhumi means "golden land" or "golden peninsula" as a traditional name for the Thailand-Cambodia-Laos-Burma region. In January 2002, NBIA started construction on the passenger terminal.

Finally, after numerous delays, the airport opened for limited service on 15 September 2006 and opened for all commercial flights on 28 September 2006. Months

into its opening, issues such as congestion, construction quality, signage, provision of facilities, and soil subsidence continued to cause many problems for the airport, prompting calls to reopen Don Muang to allow for repairs to be conducted, especially from low-cost airlines. The Thai junta announced its intention to reopen Don Muang permanently as a second international airport, despite objections from Airports of Thailand, the Civil Aviation Department. However, Prime Minister Surayud Chulanont decided on 16 February 2007 not to reopen Don Muang as a second international airport for the city. Only domestic flights would still have operations at Don Muang, such as those with no flight connections. The government would do a six months study and come out with a proposal to determine if other flights should move back to Don Muang.

According to the above discussion of the Suvarnabhumi Airport, it can be concluded that this project has been bogged down for the past three decades because the Thai national government has changed hands several times. For example, in 1973 the project looked set to take off, but came one day short of being approved when a popular student uprising succeeded in overthrowing the government, and the project was shelved indefinitely. As a result, it was not until the early 1990s that the Thai government decided to revive the project. The need for a new International Airport became a national agenda item with the release of the government's five-year plan by the National Economic and Social Development Board (NESDB). In April 1991, Premier Anand Panyarachun approved the Second Bangkok International Airport (SBIA) and placed it under the control of the Airport Authority of Thailand (AAT).

There were additional delays for the airport project again in 1996. When General Chavalit Yongchiyudh followed Banharn as Prime Minister, he immediately called for

the airport project to be shelved for an indefinite period. It was later revealed that General Chavalit planned to relocate the airport to the Bang Pu district in Samut Prakarn. This policy switch was seen as damaging, especially to foreign investors' confidence. Allegations of corruption and economic mismanagement led to General Chavalit's government being voted out of office in 1997, a few months after the floating and subsequent plunge of the Thai currency.

**Suvarnabhumi International Airport Study Area**

Suvarnabhumi is located 23 kilometers (14.29 miles) southeast of the Bangkok Metropolitan Area, which is in Bang Phli District, Samut Prakarn province (Figure IV.1). The study area of this dissertation will focus on the radius of 12 kilometers from the airport, while the center is at the passenger terminal. Therefore, the total study area will cover about 576 sq. km (222.4 sq. mile) of surface land. In addition, the study area within 12 kilometers of the airport will include some part of eight districts southeast of the Bangkok Metropolitan area, and 10 districts in Samut Prakarn province. All eight districts in the Bangkok Metropolitan Area that are included in the study area are Saphan Sung, Nong Jok, Bueng Kum, Bang Kapi, Wang-Thong Lang, Suan Luang, Prawet, Min Buri, and Lard Krabang district. In Samut Prakarn province, the 10 districts that are included in the study area are Rachathewa, Bang Keao, Bang Phli Yai, Bang Chalong, Bang Pla, Srisa Cholakhe Noi, Srisa Chorakhe Yai, Nong Pru, Bang Sao Thong, and Bang Bo.

Suvarnabhumi International Airport has an initial capacity of 45 million annual passengers, 76 flights an hour, and over 3 million tons of cargo. Two runways with a distance width of 2,200 meters, each 3,700 meters and 4,000 meters long, are able to

accommodate the Airbus A380. The airport also includes 51 aircraft parking bays at aerobridge gates of which four are designed to handle the super jumbo Airbus A380, and 69 remote parking bays and two car-parking buildings connected to the passenger terminal to serve over 5,000 cars. A gross 563,000-square-meter area is set for an assortment of 24/7 duty free shops. The completed project will feature four runways, resulting in an ultimate capacity of 100 million annual passengers, 112 flights an hour, and 6.4 million tons of cargo. Suvarnabhumi International Airport is projected to be the one of the busiest airports in Asia, operating as many as 76 flights an hour.

The Bangkok Metropolitan Administration has planned to provide several corridors and public transit to connect the new airport and the city center. Road access to the new airport will be provided by a series of new highways connected to Bangkok's existing outer ring road. The main access road is an elevated five-lane road that leads from the passenger terminal through the northern part of the site to the new Bangkok–Chonburi highway. Construction of these links and access roads were completed by late 2005.There are proposed plans to extend the Skytrain from Onnuj to the new airport, but no decisions have been made to date; also SRT's high-speed rail project from Huay-Kwang to Lad Krabang to Chonburi will have a spur line connecting to the new airport.

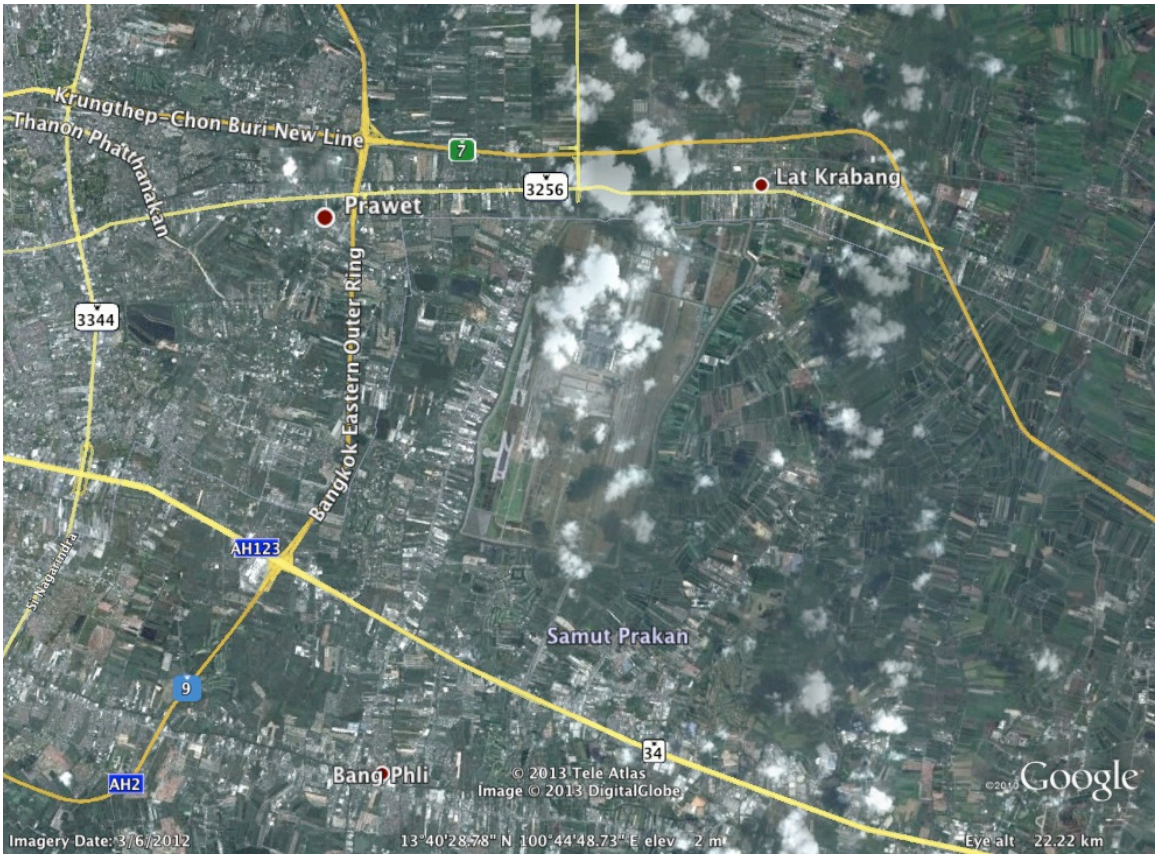



**Figure IV.1: Map of Suvarnabhumi International Airport (source from Google Earth)**

## Communities Surrounding the Airport Area

Within the radius of 12 kilometers from the airport, there are five sub-centers, which are in the suburb area of the Bangkok Metropolitan Area, while three of them are southeast of the Bangkok Metropolitan Area and the other two are in Samut Prakarn province. These sub-centers will get the direct impact from the new airport project. The five sub-centers are Bang Kapi-Hua Mak, Srinagarindra-Bang Na-Trad, Lard Krabang, Bang Phli-Teparak, and Bang Bo-Klong Dan.

Bang-Kapi-Hua Mak Sub-Center

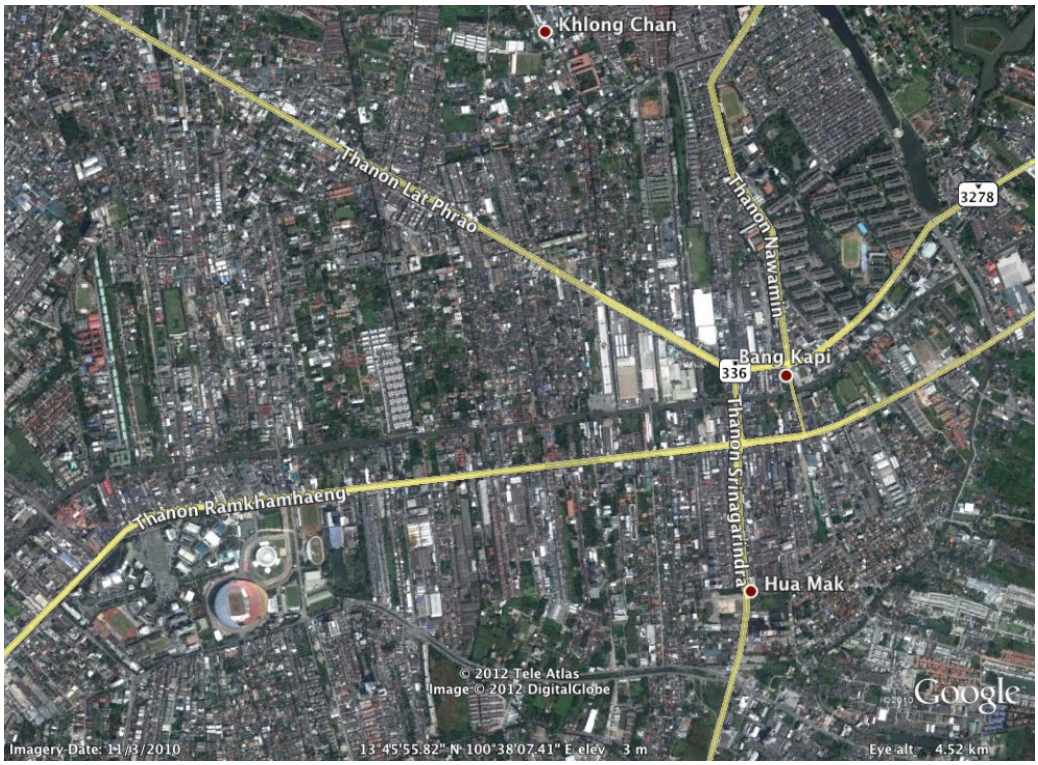



**Figure IV.2: The Area of Bang-Kapi-Hua Mak sub-center (Source: Google Earth)**

This sub-center is northeast of the Bangkok Metropolitan Area, in the middle between inner Bangkok city and Suvarnabhumi International Airport (Figure IV.2). The communities in this area consist of large-scale residential development, low and high order retail businesses, Ramkamheang University, and Rajamangala National Stadium. Rapid growth in the development of infrastructure since 1970 has caused the increased development of large-scale residential estates, which also attract various kinds of retail businesses to gather in this Bangkok suburb (Kaewlai, 2007, p.107). Since the area offers a high concentration of residential and retail business developments, such as shopping malls, grocery stores and fresh markets, the land values in this area are very high in order to compete for locations in the area compared to other sub-centers in the study area. In terms of the retail businesses, the developments of retail businesses usually cluster along

the major roadways, such as Ramkamheang Road, Lat Pharos Road, and Srinagarindra Road. Moreover, the low-density residential developments are widespread all over the area surrounding the retail business developments, while the high-density residences tend to cluster in the area around Ramkamheang University and the Bang Kapi Market (Lat Phrao-Srinakarindra intersection) to support the needs of people who would like to live closer to the university and to their workplaces in the area.

Srinagarindra-Bang Na-Trad Sub-Center

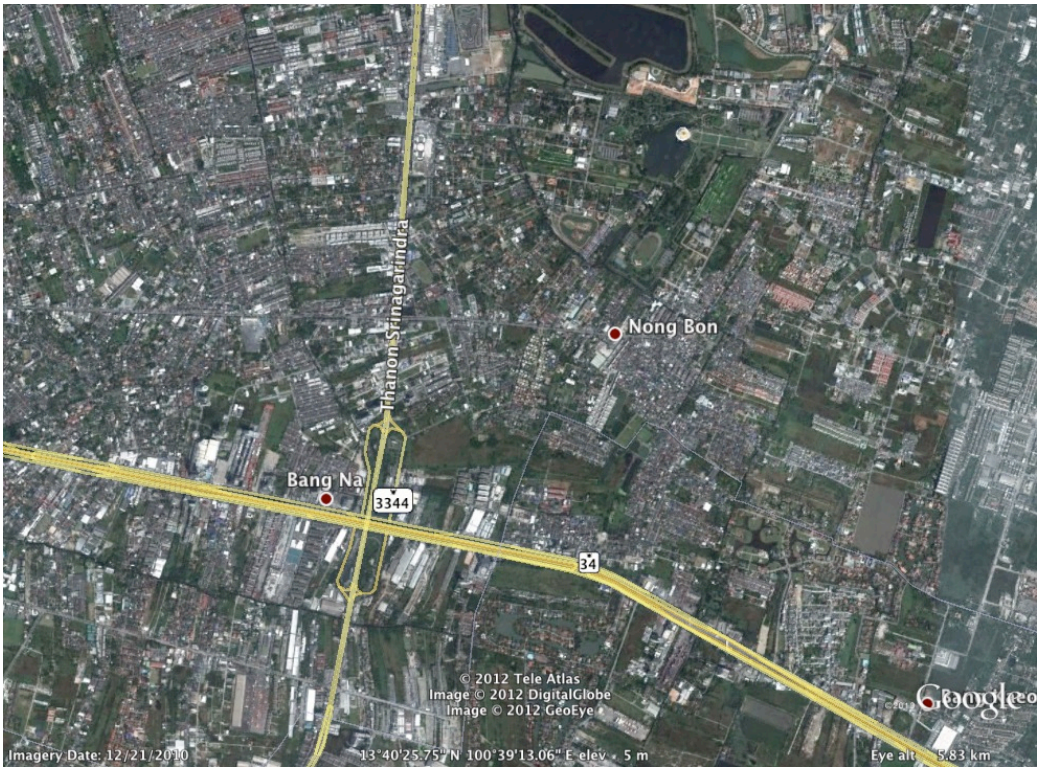



**Figure IV.3: The Area of Srinagarindra-Bang Na-Trad sub-center (Source: Google Earth)**

The area of Srinagarindra-Bang Na-Trad sub-center is located in the southeast corner of the Bangkok Metropolitan Area (Figure IV.3). The communities in this sub-center area are the fastest growing in the 20 years since the construction of the Srinagarindra Road as Srinakarindra became major roadway, the retail developments grew rapidly, with clustering of warehouses, offices, and shopping malls along the street,

while the development of residential estates grew side by side around them. With the cluster of retail businesses and high-density residences, the property values along the street increased dramatically throughout the periods of time, while the property values of single housing units may increase because of its proximity to the amenity of Suan Luang Rama IV (Public Park). Since Srinakarindra Road is connected to the major eastern corridor, the Bang-Na Trad highway, the high accessibility to markets in the central Bangkok Metropolitan Area and manufacturing facilities as well as to the eastern seaboard and the airport will attract warehouses to be located along to the Srinagarindra Road, and Bang Na-Trad highway. Moreover, along with the expansion of the Bang Na-Trad highway, low and high order retail businesses tend to cluster along the highway corridor because of the presence of high-accessible locations close to the highway. Therefore, land along this major corridor will be developed intensively for residential, commercial, and industrial developments.

Lard Krabang Sub-Center

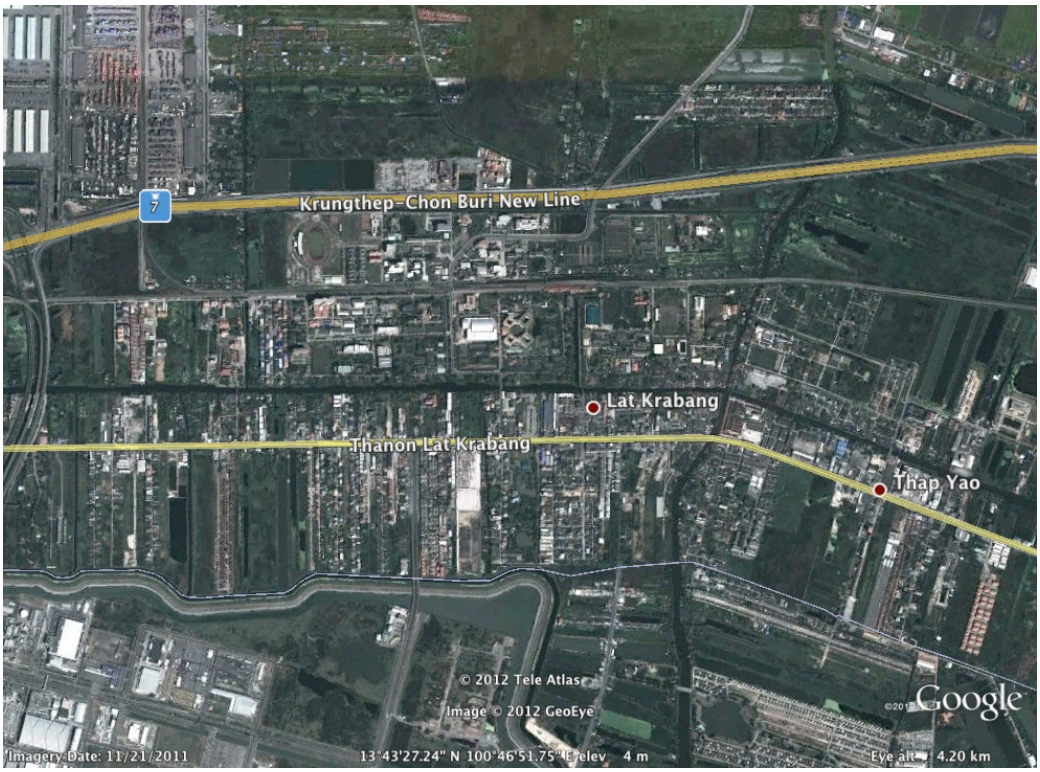



**Figure IV.4: The Area of Lard Krabang Sub-Center (Source: Google Earth)**

Lard Krabang sub-center is in the area south of Lard Krabang District along Lard Krabang Street, which is close to the Suvarnabhumi International Airport (Figure IV.4). The main community in this area is called Hua Takhea and combines an old style market waterfront of Prawet canal with a modern market. In the past, the old market at Hua Takhea was a major point of goods distribution in the area, while the canals around the area provided high-accessibility to the location. Therefore, the value of the property in the past reflected higher prices closer to the canal. Since the rise of the automobile, a street network has been built through the area, which has caused the waterfront community to decline, while at the same time the modern market developments plays an important role in the area along the major roadways. Mostly, the retail businesses in the area are related to low-order retail businesses, which provide daily goods and products

for people in the community. The area is located close to the King Mongkut's Institute of Technology Ladkrabang. As a result, there is not only a high concentration of the low-order retail businesses, but also high-density residential developments, such as apartments and condominiums, that cluster along the major roadways to provide living places for students and staff of King Mongkut's Institute of Technology Ladkrabang.

Bang Phli-Teparak Sub-Center


**Figure IV.5: The Area of Bang Phli-Teparak Sub-Center (Source: Google Earth)**

Bang Phli-Teparak sub-center is located in Bang Phli district, Samut Prakarn province (Figure IV.5). The role of the community is to support the growth of the Bangkok Metropolitan Area, Samut Prakarn, the development along King Kaeo Road, and the expansion of the Teparuk industrial area. The Fourth (1977-1981), Fifth 1982-1986), Sixth (1987-1991), and Seventh (1992-1997) National Economic and Social Development Plans emphasized decentralization of industry and economic growth from

the capital region to the provinces. Plans were made for the establishment of industrial estates under the direction of the Industrial Estate Authority of Thailand at Lard Krabang, also in the Bangkok vicinity, which includes the area in Samut Prakarn province, in order to support the Eastern Seaboard Development Program. The new development of small and medium businesses and warehouses clusters along Teparak Road and King Kaeo Road. In terms of residential land, many of the residential estates in the area are single housing units located farther away from the street front, but still with access to major roadways by small streets or lanes. Moreover, the retail business developments also cluster along the major roadways, which are low-order retail businesses that cater to the daily needs and products for the local community.

Bang Bo-Klong Dan Sub-Center

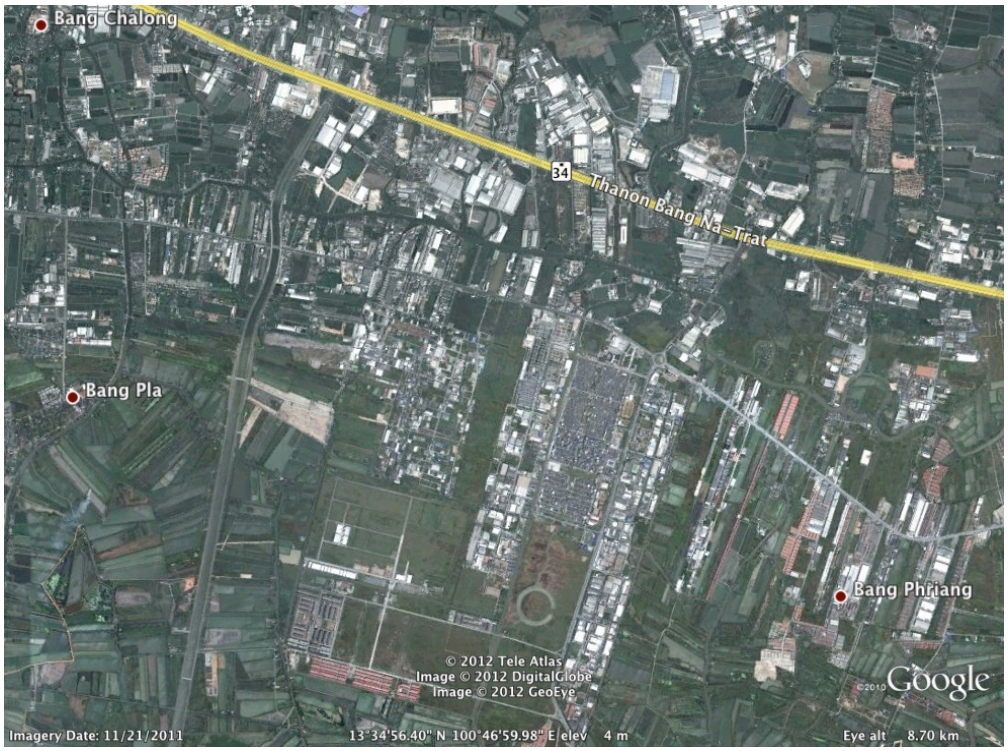



**Figure IV.6: The Area of Bang Bo-Klong Dan Sub-Center (Source: Google Earth)**

Bang Bo-Klong Dan sub-center is in Bang Sao Thong district, on the fringe of Samut Prakarn province, which includes the area of Muang Mai Bang Phli (Figure IV.6). This

community consists of a single and multi-affordable housing development provided by the National Housing Authority, Muang Mai Bang Phli Industrial Estates, low-order retail businesses, schools, hospitals, and parks and recreations. Furthermore, the National Housing Authority provided single and multi affordable housing units in this area to support the increasing number of workers in the area because of the relocation of new industrial businesses in the Muang Mai Bang Phli Industrial Estate. This sub-center includes not only the new development in Muang Mai Bang Phli, but also the old community along Teparak Road and the surrounding area. In the old community, the small and medium size industrial businesses were highly concentrated along the major roadway, Teparak Road, because of the easy accessibility of the location. Similar to the industrial businesses, the local retail businesses tend to cluster along Teparak Road because of the location along the major roadway. Furthermore, in the area around the old and new communities, the lands are still preserved for agriculture and are used as a buffer zone to create a better environment.

**Industrial Activities Around the Airport Area**

Because of the lack of enforcement of zoning regulations and policies in the past, the industrial businesses around Suvarnabhumi International Airport are spread all over the area. Mostly, they are clustered along major arterials and highways, especially in Samut Prakarn province along the Teparak and Sukhumvit Road. In the study area of 12 km from the airport, there are four industrial estates and one inland container depot. The four industrial estates are Bangchun, Lard Krabang, Aunyathani, and Bang Phli Industrial Estates.

**Table IV.1: The Number of Factories by Industrial Estate (source from TEENET 2007)**

| Industrial Estates | Number of Factories | | | Total |
|---|---|---|---|---|
| | Industrial Businesses | Services | Commercial Busienesses | |
| Bangchun Industrial Estates | 74 | 3 | 1 | 78 |
| Lad Krabang Industrial Estates | 198 | 35 | 46 | 279 |
| Aunyathani Industrial Estate | 60 | 6 | 6 | 72 |
| Bang Phli Industrial Estate | 149 | 6 | 2 | 157 |

The information in table IV.1 about the total number of factories in each industrial estate was provided by the Thailand Energy and Environment Network (TEENET). In 2007, the Lad Krabang Industrial Estate was the largest industrial estate in the study area with a total of 279 factories, with the major industrial businesses being related to electronic equipment. The industrial estate is located about 9.50 km north of the airport. Moreover, the second largest of the industrial estates is Bang Phli Industrial Estates, which is about 13.50 km southeast of the airport. This industrial estate consists of 157 factories, with the major industrial businesses being related to electronic devices and equipment. The Bang Chun Industrial Estates is located 13 km northwest of the airport. The main businesses in the industrial estate are related to food production. Finally, the Aunyathani Industrial Estate is located about 5 km east of the airport. Most businesses in this industrial estate are related to jewelry products.

These types of industrial businesses, such as electronic devices and equipment, clothing, freshly-cut flowers, and jewelry products, need to locate their plants and distribution centers close to the air transportation facilities in order to provide fast delivery to their customers around the world. This is the concept of just-in-time, which was proposed by Kasarda (1999). In addition, the underlying concept of the industrial estates is related to Ratcliff's (1949) idea that industries are locationally linked to others by either transportation economies or agglomeration economies of industrial activities.

That means one business can benefit from another if it has similar types of production. Therefore, these industries will cluster together in the same area to reduce transportation costs.


**Figure IV.7: Lad Krabang Inland Container Depot (Source: The Geography Transportation System website)**

Lad Krabang Inland Container Depot (ICD), with an area of 200 acres, is located 5.35 km north of the airport and about 30 km from downtown Bangkok. The ICD construction was begun in 1993 and completed in 1995. The ICD was proposed to act as the satellite terminal to the port of Laem Chabang, which includes a rail terminal and a customs clearance facility as well as government agencies (custom, inspection, quarantine) on the site. When the ICD began operation in 1997, the number of containers used on site was 291,000 TEU. By 2007 the number of containers increased to 1,669,000 TEU. Of this number, 75 percent of the containers arrived at the facility by road and 25 percent by rail.

**The Existing Transportation Network in the Study Area**

Suvarnabhumi International Airport is located in the eastern periphery of the Bangkok Metropolitan Area, where the area has experienced rapid growth with the development of new residences, offices, and light industrial businesses. Bangkok City is enhancing its role as decentralization while the new developments are dispersing to the area. The Srinagarindra Road, Bang Na-Trad Highway, and Wat King-Keaw Road attract numerous developments, including a new Inland Container Depot (ICD) at Lad Krabang to serve container traffic from the Laem Chabang seaport. Over the past decade, this growth, averaging 40 percent annually, has resulted in severe highway congestion problems in the area. (Report on ground access to Second Bangkok International Airport, 1993).

Bang Na-Trad Highway

The Bang Na-Trad Highway is the main highway between the Bangkok Metropolitan Area and the southeast region of Thailand, which includes the Suvarnabhumi International Airport and Laem Chabang seaport. This highway is located on the south side of the Suvarnabhumi International Airport. In the past, it was a divided highway varying from 2 x 2 lanes to 2 x 3 lanes with two-lane frontage roads. Now the highway had been expanded to a full 8-14 lanes wide from its junction with Bangkok's First Stage Expressway at Bang Na intersection to Bang Phli.

Buraphavitee Expressway

The Buraphavitee Expressway is a 55 km long and 6-lane elevated highway that runs above the Bang Na-Trad highway from the Bang Na intersection to Chonburi and is owned by the Expressway Authority of Thailand (EXAT). The project, completed in

2000, was intended to redistribute traffic flow and reduce the traffic congestion on the Bang-Na-Trad Highway corridor. Also, the project serves the Suvarnabhumi International Airport and helps promote the Eastern Seaboard Development Plan as part of the Seventh National Economic and Social Development Plan (1992-1997).

The New Bangkok-Chonburi Highway

According to the Seventh National Economic and Social Development Plan (1992-1997), the Thai Government specified that the Eastern Seaboard Development Plan construct the New Bangkok-Chonburi Highway to connect Greater Bangkok and the southeastern region of Thailand and also serve the Suvarnabhumi International Airport. This project, begun in 1994 and completed in 1998, was built to promote decentralizing economic functions to ease the over-concentrated situation in the Bangkok Metropolitan Area.

The New Bangkok-Chonburi Highway is 83 km long with total of eight controlled access intersections along the highway. The highway had four lanes initially. However, after the expansion of the highway between the Sri Nakarindra intersection and the entrance of the Suvarnanbhumi International Airport, the highway now has eight lanes (2 x 4). The highway starts from the Rama IX-Ramkhamheang Road intersection to Lad Krabang and joins with the new Chonburi-Pattaya Road, south of Chonburi town.

The Bangkok Eastern Outer Ring Highway, Eastern Section

The highway project was designed to connect northern Bangkok and the Eastern Seaboard region as an element of the Eastern Seaboard Development Plan in order to redistribute traffic flow and to relieve traffic congestion in the Bangkok area. This project was begun in 1993 and opened in 1998.

The Bangkok Eastern Outer Ring Highway is 62 km long with a total of eight lanes and (2 x 4) lane controlled accesses. Also, the highway includes a frontage road, which is 2 x 2 lanes on both side of the main access controlled highway. The highway runs south from the intersection of Highway No.1 and Highway 32 at Bang Pa-In through eastern Bangkok to join with Bang Na-Trad Highway at Bang Phli, and then connects with the Bang Phli-Suk Sawat Expressway. The highway has become an important access route for traffic between the Suvarnabhumi International Airport and the areas south, southwest, and northwest of the airport.

Bangkok Airport Rail Link

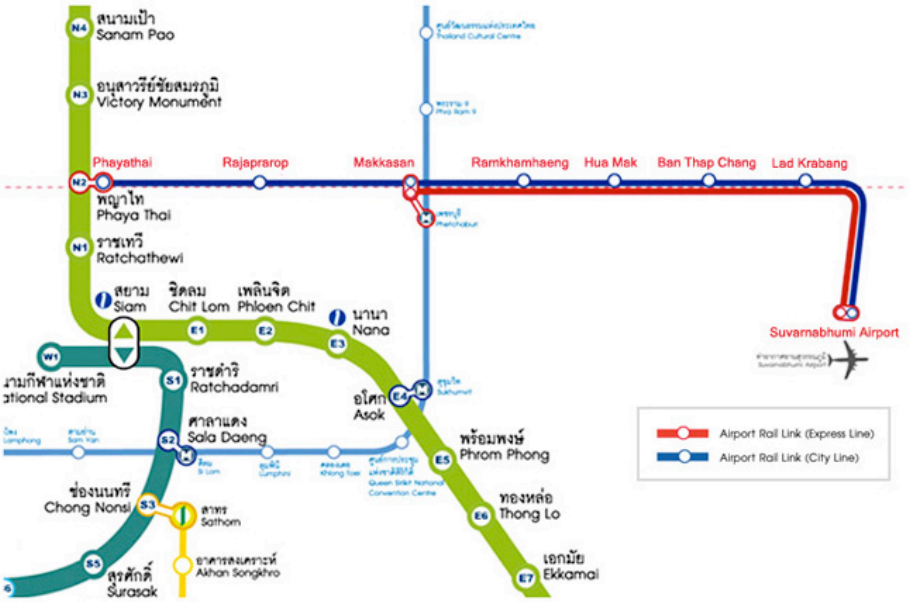



**Figure IV.8: The System Map of Bangkok Airport Rail Link (Source: Airport Link official site)**

The airport rail link provides direct rail service from the City Air Terminal in Bangkok's Makkasan area to the Suvarnabhumi International Airport (Figure IV.8). The airport rail link also serves local communities with local stations along the route. The services are comprised of two lines, the non-stop Express service and the City Train service. The express line provides 15 minute service between Bangkok City Air

Terminal (BCAT) from Makkasan to Suvarnabhumi Airport and stops only at Makkasan Station (original terminal) and Suvarnabhumi Station (end terminal). In addition, this line provides 30 minute service between Phyathai Station to the end terminal at Suvarnabhumi Airport and stops at 6 stations along the way, including Rajprarop Station, Makkasan Station, Ramkhamhaeng Station, Hua Mark Station, Thab Chang Station, and Lad Krabang Station.

# CHAPTER V

# METHODOLOGICAL DISCUSSION

The empirical analysis consists of two steps. First, simple regression analysis based on Alonso's urban land market theory will be used to explain the urban land value pattern in the Suvarnabhumi International Airport area throughout the three periods of time (before, during, and after the airport development). The bid-rent model is applied to examine the spatial relationship between the urban land values and the designated airport location. Several urban land value studies have been conducted to demonstrate the Alonso urban land market theory, including: the study of Seattle (Seyfield, 1963); the study of the density function (Mill, 1972); urban land values of city of Akron, Ohio (K. Dutt and Khan, 1982); the economic rent of an airport (Flores-Fillol and Nicolini, 2006); residential land value in Denver (Brock, Hoppe, and Williams, 2008); the centrality of Denver's urban land value (Adams, Barker, and Bartlett, 2008); and the impact of hypermarket on commercial urban land values (Sakhakara, 2011).

Second, the stepwise multivariate urban land value model will be used to examine the exogenous additional factors that may have impact on land values. Many empirical analyses have been conducted to examine land values by using hedonic-type multiple regression, such as; impact of airport (Nelson, 1980, 2003; McMillen, 2004; Rahmatian, and Cockerill, 2004); impact of highway traffic noise (Kim, Park, and Kweon, 2007); impact of rail transit (Ferguson, 1984; Debrezion, Pels, and Rietveld, 2003); sport arenas (Ahlfeldt, and Maennig, 2007), historical landmark district (Cebula, 2009); and the impact of hypermarket on commercial urban land values (Sakhakara, 2011). This dissertation employs the bid-rent model to examine the impact of the airport on the prices

of land, while the multivariate regression analysis will be used to examine whether land values around the airport are a function of additional factors, such as accessibility and amenities over time periods.

**Bid-Rent Model of Urban Land Use Location (Simple Regression Analysis)**

According to the discussion in chapter 2, the object of the bid rent function approach is to construct an equation for urban land value assessment in each period of time and then to examine the impact of the distance to the airport to ascertain its effect in the equation. The impact variable in this case is the distance to the airport. The bid-rent curve in this model will determine how the distance to the airport affects the land value assessment. Considering that the bid rent model is the foundation of urban land market studies, a number of researchers continue exploring and developing analytical methods to explain the changes in land values according to the significance of the city centers or magnet points. A large number of scholars have insisted on the principal concept of bid rent theory - that the distance to and from the center activities plays a significant role in influencing prices of land.

Various agencies and professionals have conducted research based on the well-known theory of bid-rent theory. Historically, the concept of bid rent stems from the well-know economist, von Thunen (1826). His study primarily focused on analyzing the pattern of land use and land values in agriculture area by using the concept of economic rent to explain the distribution of various agriculture land uses around the market. The rent each agent can bid at each location is explained by the saving in transportation costs with respect to a more distant site. Later, Alonso's studies (1960, 1964) used the same

concept to create the formal model by generating a series of land use zones from the intersection of different bid rent curves according to the discussion in chapter 2.

In 1963, Warren Seyfield conducted a study of Seattle based on Alonso's urban land use theory and examined whether the values of land increased as the distance to market center increased and the accessibility decreased. Seyfield considered various functional relationships between the distance to market center and land value, but the result is associated with the simple linear function and a power function. The linear function can be represented as follows:

$$LV = a - bD \qquad \text{Equation 5.1}$$

In terms of the power function, this function represents the non-linear function, which is similar to Alonso's expectation. The power function can be expressed as:

$$LV = aD^{-b} \qquad \text{Equation 5.2}$$

where $LV$ is land value, $D$ is distance to city center, and $a$ and $b$ are constants representing the value of intercept and the slope of the regression line. This notation is the same for both equation 3.1and 3.2.

To determine the relationship between site value and location, the best location was found by the highest measure of association, the index of correlation, and the lowest standard error of estimation The results provide strong support of Alonso's hypothesis that the slope of the bid rent gradients are all negative in every directions, and the

correlation coefficients of the curvilinear function rather than linear function are highly significant. Also, the results confirm that the households and firms that are located closest to the center maximize profits by reducing transport costs.

In 1972, Edwin Mills conducted a study of the density functions associated with the different types of land use patterns for 18 U.S. Metropolitan Areas. He found out that some previous studies had provided strong evidence that population density falls off smoothly and at a decreasing rate as one moves out from the city center. These earlier studies found that the negative exponential density function provides a good approximation, which can be written as;

$$D(u) = De^{-\gamma u} \qquad \text{Equation 5.3}$$

where $D(u)$ is the density $u$ miles from the center, $e$ is the base of the natural logarithm, and $D$ and $\gamma$ are parameter estimates from the data.

The results of the averages density gradients associated with each type of land use through out the four periods of time indicate that the density gradient of the retailing is the steepest. That means retailing dominates the central city location compared to the residential land use, which dominates the peripheral locations. This result supports Alonso's study of 1964. Moreover, all five-density gradients associated with population, manufacturing, retailing, services, and wholesaling have become less steep over time periods due to postwar suburbanization process. This is the result of the increasing number of people who live and work beyond the edge of the central city as the growth of population in the metropolitan area increases dramatically.

Later in 1982, Ashok K. Dutt and Abdullah Al-Mamun Khan did a study on the urban land values of Akron, Ohio. This study examines the spatial relationships between assessed land values and selected variables, which include the distance to the Central Business District (CBD). They suggested three hypotheses: (1) land value tends to decline with increasing distance from the CBD, but the degree of association between the two variables will be very insignificant; (2) the inverse relationship between commercial land value and distance will be relatively stronger; and (3) residential land value, when considered separately, will not show a distance-decay function at all (Duntt and Khan, 1982, p.115). 508 lots throughout the city were selected. Then a grid map of the city was created, numbers were assigned to the intersecting points falling within the city's limits, and then the random data from 20% of the assigned point were collected. The lot sizes in acres and straight-line distances in miles from the central business district were also collected as other variables.

The Pearson's Product Moment Correlation coefficients were used to test the hypotheses as well as the strength of the relationships between the variables. In this case the multiple regression method was used to determine the effects of the major factors on land values, while the city was divided into four sections and applied the multiple regression models to each sector. The results of the study indicated that the CBD had the peak land values, while other areas around the CBD also have high values. The highest values were found around commercial areas with the shopping centers, next to important street intersections, high-income residential areas, and a spot of light industrial development. Furthermore, the correlation coefficient between land values and distance indicates a negative significance. Commercial land values and the distances were shown

to be slightly significant, while the residential land values were found to have increased with the distance from the CBD.

According to the concept of the bid-rent function and discussions of the idea of an aerotropolis (airport city), Ricardo Flores-Fillol and Rosella Nicolini (2006) did a study to examine the conditions allowing for the formation of aerotropolitan areas as large industrial areas with a high concentration of the commercial activities in the area surrounding of cargo airports. Land competition around the airport takes place among the service operators, firms, and farmers, while firms and service operator can take advantage of location close to the airport center. They classified the airport into two categories: cargo and passenger. The comparisons of the two categories determine the existence of an aerotropolis (Flores-Fillol and Nicolini, 2006, p.2). In this study the distance to the airport will be used to determine the changes in location rents of firms and service operators for both types of airports. The results of the analyses indicate that, in the presence of a cargo airport, firms utilize facilities from service operators quite a lot in presence of a cargo airport. That means the firms let their service operators occupy land plots in the proximity to the airport. In terms of a passenger-type airport, firms do not care about the service operators' land plot proximity to the airport, but they still care about the size of their own land plot. Since the bid rent function is decreasing with respect to the distance from the airport, firms choose to settle farther than the service operators do (Flores-Fillol and Nicolini, 2006, p.18).

In 2008, a group of the students (Brock, Hoppe, and Williams) from the urban spatial analysis class at the University of Colorado at Denver did a study on the impact of Denver's CBD on residential land value. This study extended Seyfried's Seattle study.

The study area focused on a 12 miles radius from Denver's CBD at the intersection of California St. and 16th St. in downtown Denver. The average residential land values were collected along the compass ray at 0.5 mile intervals in all four directions (north, east, west, and south). In terms of the methodology, the researchers used both the linear and non-linear form of simple regression to examine the impact of the CBD on the residential land value. The results of the two models indicate that in two of four directions (south and east), the linear regression model produced a higher correlation coefficient than the non-linear regression model (power function), while the relationship between residential land value and the distance to CBD is non-linear for the north and west directions. Moreover, they claim that residential land values are highest in Denver's CBD for three of four directions (north, east, and south). The exception occurs in the west direction, where the highest prices of residential land values occur 0.5 mile west of the CBD.

Similarly to the Brock, Hoppe, and Williams's study, in 2008 another group of students (Adams, Barker, and Bartlett) in the same class did a similar study on the impact of the Denver's CBD on urban land values. They used the same context of Seyfried's 1961 study to investigate the relationship between the city center and urban market land values. In the study, three hypotheses were proposed: 1) the California & 16th St. intersection has the highest land values in all of the city, 2) market land value should decrease with increasing distance from the CBD, and 3) additional centers outside the CBD, such as the Denver Technological Center, may decrease the influence of the CBD. The study area focused on 10 miles from the CBD. In terms of the urban land values, the parcels were selected randomly from the intersection of superimposed interval circles and line of four intermediate cardinal directions (NW, SW, NE, and SE). In terms of analysis,

the researchers used both simple linear and non-linear regression model to investigate the impact of the CBD on the market land values.

As a result, both models indicate the significance of the negative relationship between the distance to CBD and the market land value. In both models, the bid-rent gradient for the NW direction are the steepest among the four direction, while the SW direction is the shallowest for the linear model, and the SE direction is the shallowest for the non-linear model. However, the non-linear model is the most suitable for this analysis because of the higher correlation coefficient. From the study, they concluded that the highest land values are in the CBD, and the prices of land decrease as the distance increase from the CBD.

Another empirical study related to Alonso's bid-rent model is the PhD dissertation by Kollawat Sakhakara (2011). His dissertation focused on the impact of the hypermarket on urban commercial land value and the land use allocation of areas in the four provinces of Thailand, which include Chiang Rai, Lam Pang, Kampheng Petch, and Nakhon Sawan, as the case studies within the different three periods of time. In his study, he used the land value regression model (hedonic pricing model) to examine the impact of the hypermarkets on the commercial land values. He claimed that Alonso's bid-rent theory provides the greatest benefit to his dissertation by employing land value multiple regression or hedonic pricing model to examine the influence of hypermarket location on prices of land. In accordance with the hedonic pricing model, he used the appraised land values of three different time periods of four study areas as explained variable. He also used three groups of explanatory variables, which include commercial business characteristics, neighborhood characteristics, and accessibility. One variable,

units of commercial building, is represented the commercial business characteristic. Six variables of the neighborhood characteristics include commercial land use zoning, population density, average household income, relation to parks, direct access to riverfront, and presence of hypermarket store. Six other accessibility variables are the distance to CBD, distance to ground transportation terminal, distance to a hypermarket store, access to main streets, commercial business locations in 1.5 kilometer radius, and commercial business locations in 1.5 to 3.0 kilometer radius from the hypermarket stores (Sakhakara, 2011, p.142-143).

In this analytical process, the hedonic regression analysis employed both linear and non-linear form (double-log transformation) for the study of the four cities. Sakhakara claimed that the cities of Lam Pang and Kampheang Petch are suitable for using the linear regression, while the non-linear regression is appropriate for city of Nakorn Sawan. In case of the city of Chiang Rai, the linear regression performs well for the years 1996 and 2000, while the non-linear regression performs better in 2008 (Sakhakara, 2011, p. 15). As a result, he concluded that the proximity to a hypermarket has an influence on the increasing of commercial land values. The increasing land prices in the surrounding areas of the hypermarkets stores confirms that the parcels of land close to the hypermarkets are desired for certain types of businesses that can outbid for the land and can have benefits from the spill-over business from the hypermarket stores (Sakhakara, 2011, p.193). In addition, three influential factors affect the commercial land value: the access to CBD, direct access to main streets, and the high-income district. These three factors result in higher prices of commercial land as the distance to these factors decreased.

### The Approach of Bid-Rent Model Associated With Airport Study

This dissertation will examine the impact of Suvarnabhumi International Airport on the values of land by different types of land uses throughout three periods of time. Therefore, the simple regression analysis will be applied to the model based on the previous discussions of the bid-rent function by using two variables - the distance to the airport and appraised land values for six different types of land use: agriculture, commercial, high-density residential, low-density residential, manufacturing & warehouse, and vacant land. In the analysis of the bid-rent model, two results must be monitored closely. First, the significance of the sign of the impact variable, which is the distance to the airport, must be checked. And second, the changes of the bid rent gradients, which are determined by the coefficient of the independent variable, must be monitored to see how they change over the time periods.

Since the site of the airport was proposed in 1991, the model of bid-rent function will be constructed in three time periods (1995, 2002, and 2009). Therefore, the six bid-rent models are based on the six different types of land use. The bid-rent model for each type of land use in this analysis is in the following function form:

$$LV_i = f(Dist.AIR) \qquad \text{Equation 5.4}$$

where $LV$ is the land value assessment; i is a type of land use; and Dist.AIR is the distance to the airport, which measure, respectively, the straight-line distance from the center of the passenger terminal to the center of each group of parcels of land use.

Therefore, the linear model could be specified in the form:

$$LV_i = \alpha - \beta(Dist.AIR) + \varepsilon \qquad \text{Equation 5.5}$$

where LV is land value assessment; i is a type of land use; Dist.AIR is Distance to the airport; α is constant to represent the value that intercepts at the Y-axis; β is the regression coefficient to represent the slope of Dist.AIR; and ε is error term.

Since the value of dependent and independent variables in the analyses are various, the trend of residuals for the dependent variable gets increasingly bigger in value and creates a non-linear relationship between input and output. Therefore, to improve the bid-rent model to fit with all of those data, the curvilinear function will be used by applying the log transformation method into the equation 4.2, which is represented in the following equation:

$$ln\,(LV_i) = \alpha - \beta ln(Dist.AIR) + \varepsilon$$

Equation 5.6

By taking the log transformation on both sides of the values variables, the fit of the model will be improved and be better than using an absolute value. That is because taking logs will pull in the bigger value of residuals by transforming the absolute value into a percent of value.

## Stepwise Multivariate Urban Land Value Model

In the second part of the analysis, the model of multiple regression analysis or hedonic pricing model will be used to examine the relationship between land values and a set of other variables. The hedonic pricing model has been broadly used by many researchers in urban and real estate economics to determine the relationship between residential property values and other factors that affect the price of property by using same method of multiple correlation and regression analysis. Because of its long history of use and its reliability, researchers have adopted and developed the application of the hedonic model to use not only in urban and real estate economics, but also in a wide range of academic fields, such as environmental studies, transportation, economics, and so on. Some of the previous research is related to the hedonic pricing model in the urban economic context, such as land value in Chicago (Yeates, 1965), impact of airport (Nelson, 1980, 2003; McMillen, 2004; Rahmatian, and Cockerill, 2004), land value in Jakarta (Basuki and Han, 2001), impact of highway traffic noise (Kim, Park, and Kweon, 2007), impact of rail transit (Ferguson, 1984; Debrezion, Pels, and Rietveld, 2003), sport arenas (Ahlfeldt, and Maennig, 2007), historical landmark district (Cebula, 2009), and impact of hypermarkets (Sakhakara, 2011).

Researchers in the field of urban land economics have long been interested in urban land value to investigate the relationships between land values and a set of other variables within the context of multiple correlation and regression analysis. The hedonic model was first developed in 1961 by Griliches, who used this method to evaluate the value of quality change in automobiles. Later, in 1974 Sherwin Rosen put the hedonic model into a theoretical context and developed an empirical method for estimation, which

led to a nonlinear hedonic pricing model. He also developed a method to estimate demand and supply functions for attributes by using prices by the Griliches method. Therefore, hedonic price analysis is both a precursor and a development of Rosen's technique (as cite in Bejranonda, 1996, p.13).

In 1965, one well-known study was conducted by Maurice H. Yeates. He did a study of the spatial distribution of land values in Chicago from 1910 to 1960. The assumption of the study is based on Alonso's classical theory that land values decline with distance from the center of the city. In this study, the CBD was the area with peak land value and is surrounded by the elevated rapid transit (the Loop). As one moves farther away from the CBD, land values decline with decreasing accessibility. Yeates expected that there might be other factors that impact the land values similarly to the CBD. In his multivariate regression model, the model contains six explanatory variables, which affected the land values. The six variables include distance to CBD, distance to Lake Michigan, distance from nearest elevated subway station, distance from shopping center, population density, and the percentage of non-white population. The multiple correlation and regression analysis was chosen to examine the impact among these explanatory variables on the values of land.

He also applied the natural logarithm on both sides of the equation, and the results of logarithmic transformation appear to be most appropriate for the study. As a result, he concluded that land values will diminish with distance from regional shopping centers in the newer, more rapidly expanding, relatively high-income area of white population. In terms of accessibility to Lake Michigan, he concluded that Lake Michigan appears to have increased in relative importance during the past 50 years. For the distance to rapid

transit facilities, the evidence indicates that the impact of rapid transit facilities on land values declined after 1930 due to the rise of the automobile expressway. However, the land values were associated with high population density and percentage of nonwhite population.

In 1978, Harrison and Rubinfeld used the hedonic housing price model to estimate the willingness to pay for improving air quality in Boston. They concluded that benefit estimates are sensitive to specify the hedonic price, but are relatively insensitive to specification of the demand function. The results of their study confirm that air pollution has a significant impact on housing values, and benefits from auto emission controls depend on the functional form employed (Harrison, 1978).

In 1981, Paul Kwado Asabere conducted a study to explain the sale price of vacant lots in Accra, Ghana. He used ten variables to determine the land value: distance to CBD, distance to sea, the presence of major or class A roads, governmental zoning, land tenure effects, ethnic clustering, type of interest attached to the land, time of sale, size of the lots, and site services. In his analysis, he used the linear function to do the multiple regression analysis. As a result, he concluded that the variables for the locations, governmental zoning, some aspect of the land tenure, ethnic clustering, time-of-sale, lots size, and site services were significant and influence land values. The location next to the sea had a negative impact on land values. The land located right next to the major road had higher land values. Zoning did in fact have a way of increasing or decreasing land values. Time-of-sale had a significant effect on the land-sale price as well as the type of landholder or seller. Also, the land values had high prices when located in

a site with site services. Finally, the distance to CBD had strong relationship with the prices of land.

Bruce G. Ferguson (1984in his thesis studied the effect of the Vancouver advanced light rapid transit system on single-family property values. He examined the relationship between transportation improvements and single housing values. The transit and impact related variables were created through the hedonic model. In this case, the variables of the distance to the light rail corridor and the distance to the light rail stations created a basis similar to the distance to CBD variable. Three characteristics were used to identify the impact on housing values: physical characteristics, zoning and neighborhood characteristics, and social neighborhood characteristics. As a result, he concluded that the property location relative to future light rail stations had an impact on the price of land only in 1983. Also the effect of the line would diminish at some point over 1800 feet from the line and is nonexistent over 2400 feet from the line. Furthermore, a location closer to the track does not have an effect on the property values.

Later in 1987, Richard B. Peiser did a study to determine the effect of various factors on nonresidential land value in the Dallas metropolitan area by concentrating on the sale prices of vacant land for industrial, commercial, and office uses. The data consist of 467 vacant land transactions from 1978 to 1982. The study focuses on the approach of agglomeration for consumers of each land use as measured by the impact on the prices of land in the CBD, suburban nodes, and other employment centers. The various characteristics and variables of determinants are categorized into six categories: (1) physical site characteristics, (2) macrolocation variables and other major structural features, (3) microlocation variables, (4) development expectations, (5) neighborhood

characteristics, and (6) macroeconomic and financial conditions. The logarithmic specification was used for the analysis by taking the natural log of both sides of the multiple regression equation. He concluded that land values for the three types were affected in different ways, not only by microlocation, development expectations, and neighborhood characteristics, but also by each parcel's interaction with the dominant structural features of the city (Peiser, 1987, p.357).

In terms of the microlocation results, Peiser pointed out that proximity to the CBD has greater impact on office land than commercial land values, while it is not significant for industrial land value. Proximity to employment appeared to be more important than proximity to the CBD for industrial and commercial land. Proximity to suburban nodes appeared to be significant for office land values, but not for commercial land values. In terms of the employment agglomeration, the office land values indicated that employment proximity enhanced land values even after proximity to major nodes was taken in to account. On the other hand, industrial and commercial land values were also influenced by employment and proximity to major nodes, but only the employment variables were significant when both were used in the same equation.

Ann Basuki and Sun Sheng Han (2001) examined the spatial pattern of land values to determine the effect of various factors on the value of land in Jakarta. They used the linear stepwise multivariate regression model to examine the effect of each factor on the prices of land. In the multivariate regression equation, the five explanatory variables were used to explain the impact on land values: distance to the CDB, distance to the nearest highway entrance, commercial establishment within 1 km radius, commercial land use zoning greater than 50 percent of the total land area, and flood risk.

The results of the spatial land value pattern indicated that the most expensive land parcels had a large concentration in central Jakarta, while the lowest land value groups were located along the border of central Jakarta. Furthermore, the land values differed among the four regions that were grouped together to form the non-central area. West, and south of Jakarta had higher land values than north and east Jakarta. By using stepwise regression analysis, the results show that the physical factors affecting the price of land in Jakarta were the flood risk and distances, which included distance to the CBD, commercial establishment within the 1 km radius, and the nearest highway entrance. Among all these variables, the distance to CBD, the distance to the nearest highway entrance, and flood risk had a negative impact on the values of land, while the commercial establishment within the 1 km radius and commercial zone had a positive impact on the values of land.

Similarly to Ferguson's study (1984), a study on the impact of a railway station on residential and commercial property value was conducted by Debrezion, Pels, and Rietveld in 2003. In this study, the hedonic model was used to examine the impact of nodes in transportation networks (railroad stations) on property value. The authors suggest three major categories influencing the residential and commercial property values: physical characteristics, accessibility, and environmental amenities. As a result, they conclude that a commuter railway station has a significantly higher impact on both commercial and residential property values compared to a light or heavy railway/Metro station. They also claim that the commercial properties enjoy a higher positive impact due to the proximity to a railway station than residential properties do. They explain that within a given area accessibility can be accomplished by a number of modes, such as

railways, car, or bus. Therefore, when other accessibility modes are included, the railway stations seem to have lower impact on property value (Debrezion, Pels, and Rietveld, 2003, p.24).

Pioneering work on the relationship between airport and property values was done by Nelson (1980). Nelson used the hedonic approach to investigate the impact of aircraft noise pollution on residential property values. In the hedonic model, Nelson uses four characteristics for independent variables, which include structural characteristics, locational characteristics, neighborhood environmental-quality characteristics, and local taxes. In terms of neighborhood environmental-quality characteristics, he used the noise index to determine whether or not aircraft noise has a detectable effect on property value, while the distance to airport was used for locational characteristics. By using log linear transformation, he found that the coefficient of noise was highly significant. He explained that, if two houses have different noise environments, the difference in property values is the expected discounted present value of noise annoyance (Nelson, 1980, p.46).

Later in 2004, Rahmatian and Cockerill did a study similar to Nelson's on the impact of the large and small airport flight patterns on residential property values. They used the same categories of independent variables as Nelson used in his study (1980) to identify the impact on the property values. In this case, the distance to flight pattern was monitored carefully. They used three functional forms of linear, semi-log, and log-linear models in an attempt to search for the best estimate of the marginal costs of airport influence. The results indicated that the semi-log and log-log models are appropriate for the models rather than linear form. They also conclude that individuals consider airport

proximity and airport flight pattern in their housing purchases. There is a different between large airport and small airport affects on housing values. In other words, a home located under the flight path of a large airport has a price gradient that is significantly larger than a home located under the flight path of a small airport (Rahmatian, and Cockerill, 2004).

Also in 2004, McMillen conducted an empirical study to examine the effect of airport noise on property values around one of the world's busiest airports, Chicago O'Hare. The hedonic approach was used to examine the impact of the airport noise, while the log transformation was applied to the model to represent the nonlinearity of the relationship between dependent and independent variables. The results of the regression analysis indicate that aircraft have become so much quieter that the airport could be expanded without causing a drop in local property values or tax bases. The estimation of the housing prices may increase as much as $284.6 million in the density area around the airport after a new runway is added to the airport. However, the accessibility to the airport entrance negative impacts the property values. Other results indicated that property values are higher near stops on the elevated train line, but are lower nearer the Chicago CBD, highway interchanges, and commuter train stations. (McMillen, 2004, p.634).

In a broader context, multivariate regression analysis is typically used to estimate the marginal contribution of individual characteristics to the total values of land (Sirmans, and Bacheller, 2003, p. ii). Multivariate urban land value equations have been used to measure the effect of various factors of spatial interest on land values (Yeates, 1965; Nelson, 1980; Asabere, 1981; Ferguson, 1984; Peiser, 1987; Basuki and Han,

2001; Debrezion, Pels, and Rietveld, 2003; Rahmatian and Cockerill, 2004; McMillen, 2004; Sakhakara, 2011). According to the recent literatures, many variables are usually included in the multivariate urban land value models. Due to the large number of variables, categories are created, and the top characteristics from each category are identified. The common categories in multivariate urban land value model are: physical characteristics, accessibility characteristics, amenities characteristic, topography characteristics, time of rent, contract conditions, and so on (Yeates, 1965; Asabere, 1981; Peiser, 1987; Basuki and Han, 2001; Malpezzi, 2002; Sakhakara, 2011). According to Basuki and Han's study (2001), an example of the conceptual model of multivariate urban land value generally can take form as follows:

$$LV = f(PhyF) \qquad \text{Equation 5.7}$$

where $LV$ is the land value, and $PhyF$ is a set of physical factors that affect the prices of land, such as distance to CBD, distance to nearest highway, distance to nearest commercial establishment, zoning, and flood risk. (Basuki and Han, 2001, p.844). More specifically, the full model of the multivariate regression model can be represented in the functional form:

$$LV = \alpha + \beta_1(DCBD) + \beta_2(DHWY) + \beta_3(DCOM) + \beta_4(ZONG) + \beta_5(FRSK) + \varepsilon$$

Equation 5.8

where LV stands for land value; DCBD is the distance to CBD; DHWY is distance to nearest highway; DCOM is distance to nearest commercial establishment; ZONG is zoning categories with three land use group (residential, commercial, and others); FRSK is a dummy variable with value 1 represent high risk and a value of 0 representing low risk; $\alpha$ is intercept; $\beta_1, \beta_2, \ldots, \beta_5$ are the regression coefficients; and $\varepsilon$ is an error term (Basuki and Han, 2001, p.852).

Considering the outcome of the multiple regression analysis, researchers in this academic field are aware of the results of three statistical tests: the R-square ($R^2$) value, the T-statistic, and F-statistic. The coefficient of determination or $R^2$ is used as a convenient measure of success of the regression equation in explaining the variation in the data. The $R^2$ is most often seen as a number between 0 and 1, used to describe how well the regression line fits with all independent variables in the regression equation. An $R^2$ near 1 indicates the strength in the relationship between the regression line and independent variables in the model, while an $R^2$ close to 0 indicates that there is no relationship between the regression line and all independent variables in the equation.

Simultaneously, in regression, the t-statistic indicates the statistical significance of the relationship between the independent variable and each dependent variable, while associated with other independent variables in the equation. Considering the significant relationship between independent and dependent variables, the one with the highest coefficient will be the most influential factor on the dependent variable, while the sign of the coefficient of the significant variable will represent negative or positive impact on the dependent variable. In terms of the F-statistic corresponding to the p-value, the output is shown in the ANOVA table. The F-statistic is used to test the hypothesis between the null

hypothesis and the alternate hypothesis of the full model, while the null hypothesis states that:

$H_0$: all coefficients in the regression equation is equal to zero

and the alternative hypothesis states that:

$H_a$: At least one of coefficient in the regression equation is non-zero

If the F-value associated with large p-value is less than the F-critical value, then the null hypothesis fails to be rejected, which mean the regression model is not significant. On the other hand, if the F-value associated with small p-value is greater than the F-critical value, the null hypothesis will be rejected. That means the regression model is significant when one of the coefficients in the regression equation is not equal to zero.

**The Application of Stepwise Regression Analysis**

In multiple regression analysis, researchers have developed an ability to build appropriate multiple regression models and to interpret the result of their analyses. Stepwise regression technique is one of the most powerful methods to select the best set of explanatory variables in the model for predicting the dependent variable. There are two advantages of using stepwise multiple regression technique. First, it permits screening of a large set of numbers of potential predictors and then specifies the best ones for the model. Second, it can be used to limit the number of predictors to the few that make the

most important contributions to explain the dependent variable (Ohring, 1973,p.36). The stepwise regression procedure is an attempt to select the best predictor variables by inserting variables one by one into the equation until the regression equation is satisfactory. The order of insertion of the prediction variables is determined by using a partial correlation coefficient as a measurement of the importance of the variable. The basic procedure of the stepwise regression analysis is as follows (Draper and Smith, 1998, p. 309-310):

1. Calculate the correlation of all predictor variables and then select the first variable to enter into the equation by choosing the one most highly correlated to the dependent variable
2. Regress the first predictor variable and dependent variable to see if the overall F-test is significant, then the first predict variable should remain in the equation.
3. Recalculate the partial correlation coefficients of the rest of the variables that are not in the equation with the dependent variable again. Then choose the second variable to enter into the regression equation with the highest partial correlation coefficient.
4. With the first and second entered in the equation, the stepwise regression method will regress the equation again to see if the overall F-test is still significant. At this point the two partial F-tests of each variable will be examined if both are still significant. Then the stepwise regression will retain the second variable and put the first variable into the equation as second to see the contribution of both variables in the overall model. If the F-test is still

significant by switching the order of entering both variables, then both variables should be kept in the stepwise regression model.

5. The stepwise method selects the third variable by following the third step. Stepwise regression method chooses the one that has a highly partial correlation coefficient with the first and second variables, which are already in regression.
6. Following step 4, the stepwise regression method will regress the new equation with first, second, and third variables entered in the equation. At this point, the three partial F-values are examined. If the partial F-values of three variables are still significant, the fourth variable will be selected by following step 5. If one of the partial F-tests is not significant, then the stepwise procedure will eliminate that variable from the equation.
7. Then the remaining variable will be considered by following the above procedure. The stepwise regression procedure will stop when the remaining variables are not significant after being entered in the equation.

Considering the use of the stepwise regression method, many of researchers are aware of using this method because of the problem in variable selection processes. Wittingham, Stephens, Bradbury, and Freckleton (2006) point out three problems of using the stepwise regression analysis that researchers should pay attention to. First is the bias in parameter estimation. Researchers claim that the model selection, which is conducted through the test of parameter significance, can lead to over-fitting and incorrect significance of parameters estimation. Second, in terms of the stepwise procedure, they claim that the problem may occur in the procedure of choosing variables

entered in the equation. This problem may effect the changes in the signs of the coefficients in the regression model, which is different from the hypothesis. The problems may also be caused by high multi-collinearity problems among dependent variables, which may lead to misinterpretation of the results.

Finally, the problem may be the question of whether the stepwise regression procedure identifies the best sets of predictors entered in the model. Although the final model of stepwise regression is selected, other models may have a similar good fit, and the results may be more realistic. It is possible that the uncertainty of estimation of parameters will lead incorrectly to choosing the predictors to enter in the final model. One model may be misleading, while other models may fit well with the data. These are the common problems that all researchers should be aware of when using the stepwise regression method.

## Data Requirements for the Bid-Rent Model and Stepwise Multivariate Urban Land Value Model

In this section, the selection of study area, data collection processes, and data requirements for the dissertation analysis will be discussed based on the criteria of difficulty and limitation of available data.

### Discussion of the Selected Study Area

To focus on the impact of Suvarnabhumi International Airport on the urban land values for different periods of time (before, during, and after the airport development), a study area of 12 kilometers radius from the airport was chosen based on the available of the aerial photos from the Division Map, Royal Thai Survey Department, Royal Thai Armed Forced Headquarters. The periods of study also depended on the availability of

aerial photos (Figure V.1). The Royal Thai Survey Department took aerial photos in 1987, 1995, and 2009. These photos covered the area 12 kilometer from the airport, while the boundary of the west side of the airport is at Srinakarindra Road. This boundary became the main criterion to select the study area of the airport because, if the distance had been moved farther beyond 12 kilometers to the west, there might be many influential factors other than the airport that would impact land values. Therefore, the study area of 12 kilometers radius from the airport is the appropriate distance to identify the impact of the airport on urban land values.

In order to have equal interval years of study between 7-8 years, the aerial photo digital files of the study area for year 2002 are available from the Office of Surveying and Mapping Technology, Land Development Department, Ministry of Agriculture Cooperatives. The importance of these digital aerial photo files is that each aerial photo obtains the coordinate system of study area and can used be as a base map to compare with the hard copies of aerial photos of 1987 and 1995 and with the digital files of the year 2009, which do not have the coordinate system.

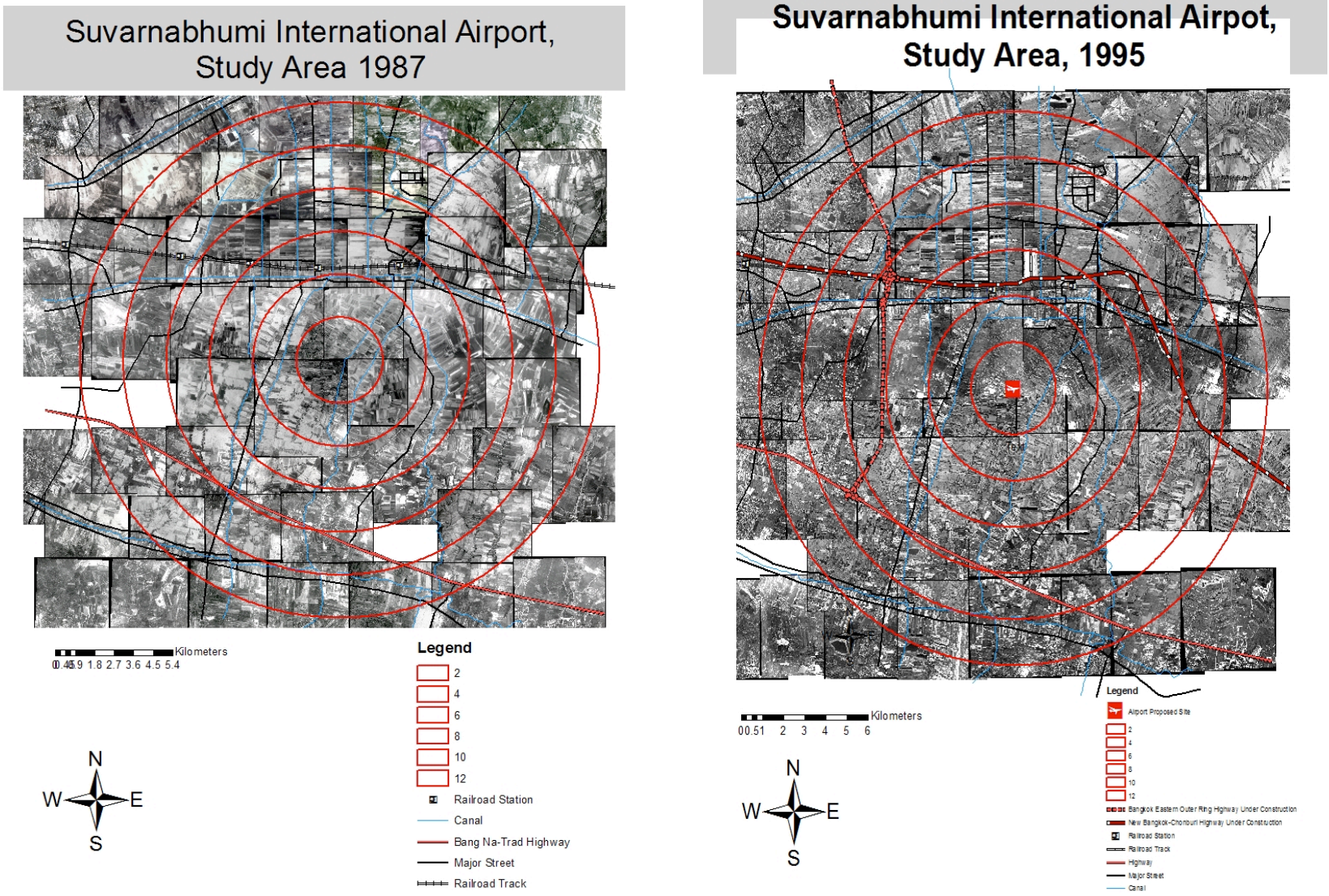
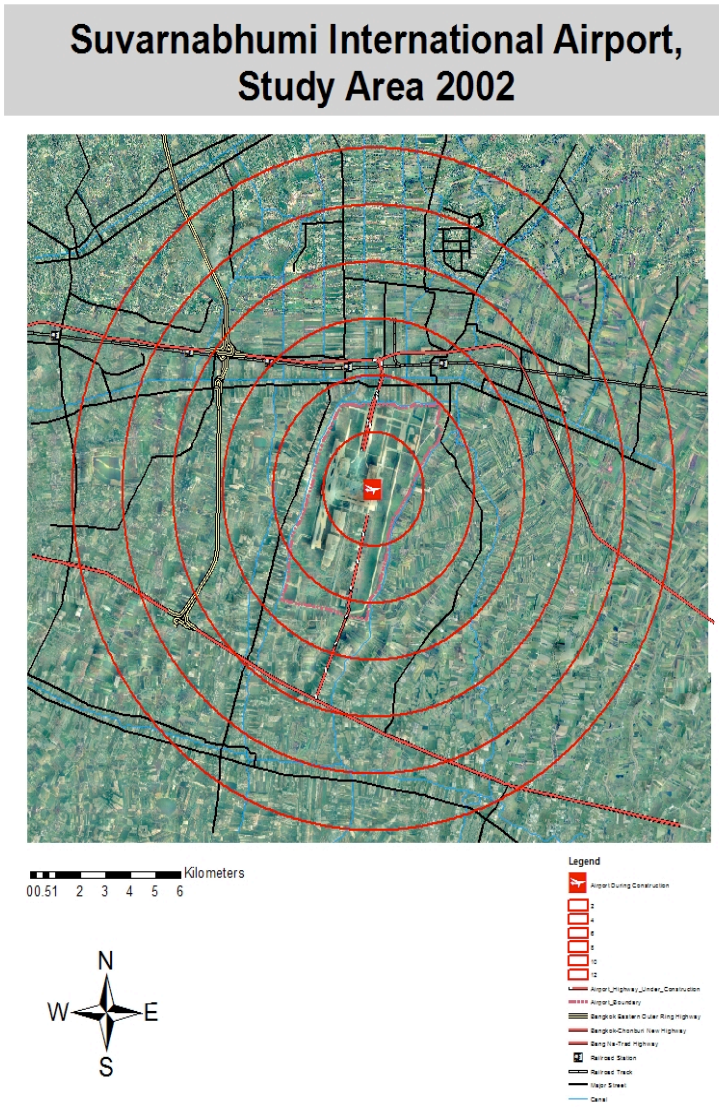



**Figure V.1: Suvarnabhumi International Airport Study Area by year 1987,1995, 2002 and 2009**



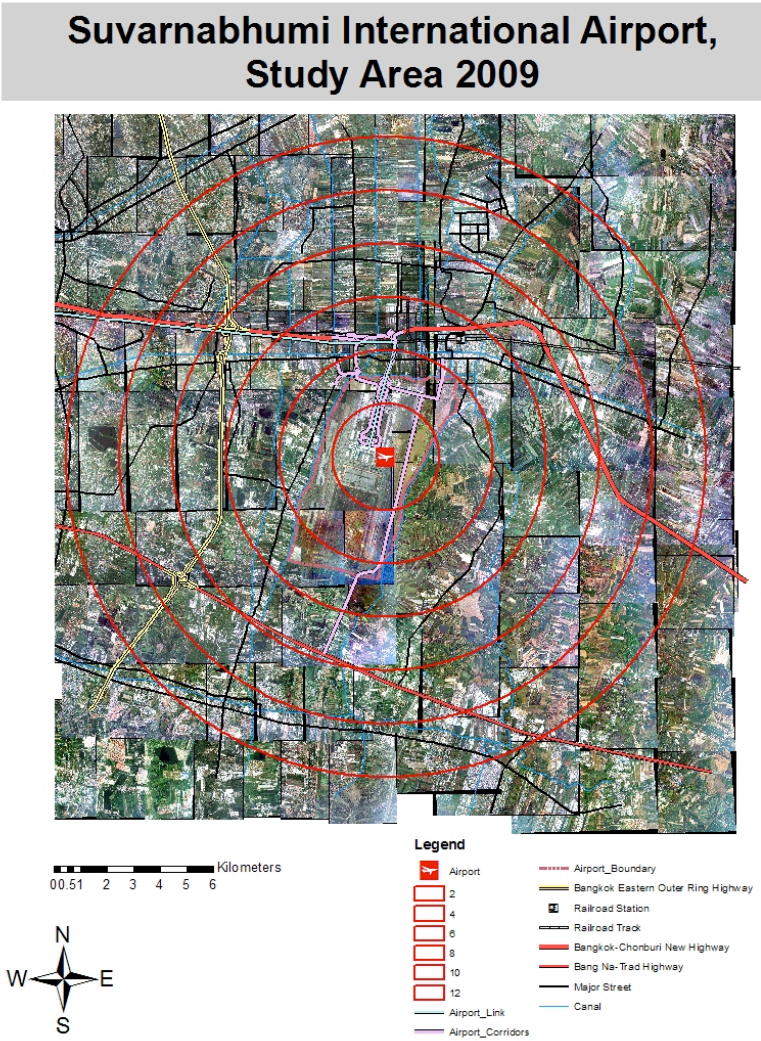




**Figure V.1 (continued): Suvarnabhumi International Airport Study Area by year 1987,1995, 2002 and 2009**

**Data Collection Processes**

The processes of the data collection were planned based on the physical characteristics of the study area and the requirements of the data for analysis associated with the previous studies. Since Suvarnabhumi International Airport is located in the area north of Sumut Prakarn province, which is next to Bangkok Metropolitan Area, the study area within 12 kilometers radius from the airport crosses two jurisdictions of Samut Prakarn and Bangkok City. The discussion will be divided into two sections. The first section will discuss what types of dataset should be used for the analysis, and the second section will focus on the process of collecting the datasets.

According to the bid-rent and stepwise multivariate urban land value model for the study of the impact of the airport on urban land values, two types of variables, dependent and independent, should be employed in the models. In both models, land values assessment will be used as a dependent variable. This dissertation will focus on the impact of the six different types of land use in the study area - agriculture, commercial, high-density residential, low-density residential, manufacturing & warehouse, and vacant land. These categories are based on a study by Edwin Mills (1972) and the classification of urban land use in Thailand. Furthermore, based on the study of the impacts of an airport on urban land values, two additional factors that influence the urban land values in the airport area - accessibility and amenity - will also be considered (Nelson, 1980, 2003; McMillen, 2004; Rahmatian, and Cockerill, 2004; Kim, Park, and Kweon, 2007; Ferguson, 1984; Debrezion, Pels, and Rietveld, 2003; Ahlfeldt, and Maennig, 2007; Cebula, 2009; Yeates, 1965; Asabere, 1981; Peiser, 1987; Basuki and Han, 2001; Malpezzi, 2002).

According to these studies, one of the important variables that should apply in the models is the accessibility factor, which includes variables of distance to the airport, distance to CBDs, distance to major roads and highways, and distance to rapid transit stations. Moreover, the amenity factor will focus only on one variable, which is the distance to canals. This variable will be used in the model, especially for agriculture land use, to represent the use of the canals for irrigation purposes. Furthermore, the different periods of time of the study (before, during, and after the airport development) will also be considered in this dissertation to determine the impact of the airport on land values.

Based on the availability of the data, this study of the impact of the airport on land values will focus on four time periods: prior to the airport (1987), after the announcement of the airport site (1995), during the airport construction (2002), and after the opening of the airport (2009). In addition, since the study area covers a large area, it is divided into four quadrants (northwest, northeast, southwest, and southeast) based on the different characteristic of the area. The northwest and southwest quadrant are in the urban area, while the northeast and southeast quadrant are in the peripheral area.

This dissertation will demonstrate that bid-rent model represents the strong relationship between distance to the airport and land value. Similar to the stepwise multivariate urban land value model, the distance to the airport should provide a strong result that is reflected in the prices of land, while other influencing factors also affect the changes in land prices.

After the types of the dataset were identified, then the processes of collecting the data were planned. There are four steps to these processes: creation of the study area map, creation of land value maps, creation of the various factors, and measurement of the

accessibility. First, the GIS program will be used to create the study area map. The digital aerial photos of year 2002, which include the coordinates, are used as the base map. The hard copy of the aerial photos for 1987 (41 copies) and 1995 (56 copies) were scanned and saved as digital files, while the digital aerial photo of 2009 were ready to be used. Then, the digital aerial photos of 1987, 1995, and 2009 were created as different layers by using the GIS program.

The second step is the creation of land value maps. However, prior to that, the digital files of land value grid blocks will be used to overlay the aerial photos of each year. Each land value grid block is divided into 16 small cells, each cell representing a page of the land value assessment book obtained at Bureau of Property Evaluation, the Treasury Department, and the Ministry of Finance. Then the six types of land use will be grouped separately for each year based on the similar type of land use and land value. Since land values vary, each group may have a variety of land values. Therefore, to assign one land value for each group, the formula of an average land value is in the form of (max + min)/2. Then the average land value assessments are obtained in the attribute table for each year and each type of land use.

Third, the various factors are created by using the GIS program as different layers. The various factors that impact the land values are the existing major roadways for each year, existing highways for each year, existing rapid transit stations (Airport Link Station for 2009), canals, recreation points, CBDs, and the airport. These layers will be created on the aerial photos of each year.

Finally, the next step is to measure the distance from each group of land use to the various factors by using tools in the GIS program, which measure from the centroid of

each group to the various factor features. Therefore, all datasets will be obtained in the same attribute table of the land values for each year.

**Data Requirements of the Analysis**

According to the bid-rent and stepwise multivariate urban land value model, one explanatory variable will be used for the bid-rent model, and twelve explanatory variables will be used for the stepwise multivariate urban land value model. The twelve variables in the accessibility factor include: distance to the airport, distance to Bangkok CBD, distance to Samut Prakarn CBD, distance to Mueng Mai Bang Phli, distance to Cha Cheng Sao CBD, distance to nearest major street, distance to Bang Na –Trad highway, distance to nearest recreation, distance to nearest New Bangkok-Chonburi Highway access, distance to nearest Bangkok Eastern Outer Ring highway access, distance to closest airport link station, and proximity to the canal. In terms of the dependent variable, the average land value assessment for six types of land use will be used. The six different types of land use are: agriculture (AGR); commercial (COM); high-density residential (HRES); low-density residential (LRES); manufacturing and warehouse (MAN); and vacant (VAC). The description of the twelve independent variables will be provided in the following paragraphs.

For the dependent variable, the average land value assessment (LV) will represent the land value for different types of land use. The government land value assessment will represent the land values in the form of the unit price (Baht per square wa), which is revised every four years. As discussed in the previous section, the average land values for each type of land use will be calculated by using the formula (max+min)/2. These

values will represent the value of each parcel of land. The difference in prices of land is related to the location of the land and the twelve influential factors.

The first independent variable is the distance to the airport (Dist.AIR). Kasarda (2000) discusses the concept of aerotropolis by assuming that the airport is a new kind of Central Business District. Therefore, the airport is represented as a CBD. A previous study by Rahmatian, and Cockerill (2004) found that the airport had an impact on the prices of the land, which decreased in a ratio to the increasing distance from the airport.

The second independent variable is the distance to the Bangkok CBD (Dist.CBD), which is located at the intersection of Sukhumvit Road and Chidlom Road and has the highest land values of the city. Previous studies have found that many businesses tend to cluster in the core area because of the advantage of agglomeration economies. Therefore, the land values in the CBD will decrease when the distance to the CBD increases (Yeates, 1965; Asabere, 1981; Peiser, 1987; Basuki and Han, 2001).

The third variable is the distance to the Samut Prakarn CBD (Dist.SMP), which is measured from each type of land use to the intersection of Sukhumvit Road and Thepharak Road in Samrong Nuea District, where many commercial businesses have clustered. The expectation is similar to the Bangkok CBD, which is that the prices of land will decrease as the distance moves farther away from the CBD.

The fourth independent variable is the distance to Mueng Mai Bang Phli (Dist.MMBP), which is the new town development located in Samut Prakarn Province (Southwest Quadrant of the airport study area). The development includes single and multi-family affordable housing developments provided by the National Housing Authority, Muang Mai Bang Phli Industrial Estates, low-order retail businesses, schools,

hospitals, and park and recreation areas. Therefore, the center of this CBD is located at the center of the development project. The expectation of this variable is that it will provide a negative impact on the values of land as the prices of land decrease as the distance from this CBD increases.

The fifth independent variable is the distance to Cha Cheng Sao CBD (Dist.CCS). The CBD of Cha Cheng is at the Government City Hall, which is about 34.50 kilometers (21.44 miles) east of the airport. This variable is another CBD on the east side of the airport and may affect the land values on the eastern plain. Therefore, the expectation of the relationship of the land values and the CBD will show that the prices of land decrease as the distance from the distance to Cha Cheng Sao CBD increases.

The sixth independent variable is the distance to the nearest major street (Dist.ST), which will be measured from each group of parcels of land to the nearest major roadway. A major street is a preferable location for any type of land use because of easy accessibility and excellent visibility. The expectation of the land value on this variable is that the closer to the main street, the higher the land values.

The seventh independent variable is the distance to the Bang Na-Trad Highway (Dist.BNTHWY). The vector distance will be measured directly from each group of parcels of land to the Bang Na-Trad Highway because it is not a limited accesses highway. Small streets and lanes are connected directly to the frontage road. This dissertation expects proximity distance to the Bang Na-Trad highway to produce a negative impact on the prices of land.

The eighth independent variable is the distance to the nearest recreation (Dist.REC). Recreation in this case refers to playgrounds, public parks, water features,

and golf courses. Land located close to the recreation can enjoy the amenity of a better environment, which affects the quality of life of the people who live close to it. Therefore, the dissertation expects the proximity to the nearest recreation to result in higher land values rather than the land that is farther away from it.

The ninth independent variable is the distance to the nearest New Bangkok-Chonburi Highway access (Dist.BCACC). Since the New Bangkok-Chonburi highway is a limited access highway, the distance to this highway will be measured from each group of parcels of land to the nearest highway access. The development of highway corridors can help increase accessibility and also reduce the transportation costs by decreasing the vehicle miles traveled. The clustering of businesses and industrial developments around the highway will cause higher prices of land, while the prices of land will drop when the distance increases outward from the highway accesses.

The tenth independent variable is the distance to the nearest Bangkok Eastern Outer Ring highway access (Dist.BEACC). This highway is similar to the New Bangkok-Chonburi highway with limited access controls. The distance to the highway will be measured from the centroid of each group of parcels of land to the nearest access of the highway. The dissertation expects higher land values near the highway accesses and lower land values farther away from the highway accesses.

The eleventh independent variable is the distance to the closest airport link station (Dist.ALS). Ferguson (1984) concludes that the property values would react to the presence of a station, and the increased accessibility reflects the fact that a location closer to the station is worth more than a location farther away. Therefore, this dissertation expects the airport link station to provide a negative impact on the urban land values.

Finally, the twelfth independent variable is access to the canals (Att.CANAL). The dummy variable will be used to represent the access to the canals, while the access to the canals provides negative impact only on the agriculture land values. As the dummy variable, agriculture lands that are adjacent to the canal are designated as “2”, while the agriculture lands that do not attach to the canal are designated as “1”. In this case, the value of the dummy variable “2” and “1” are used instead of “1” and “0” because the log transformation in the regression equation provides no meaning for “0”.

The summary of the dependent variable and independent variables is shown in table III.2 with the definitions of all variables and the expected signs of the impact on land values of each independent variable.

## Table V.1: Definitions of variables and expected signs

| Variable | Sign | Definition |
|---|---|---|
| LV | | average land value assessment |
| | **Physical Factor Variables** | |
| Dist.AIR | - | straigth line distance to airport in kilometers |
| Dist.CBD | - | straight line distance to Bangkok CBD in kilometers |
| Dist.SMP | - | straight line distance to Samut Prakarn CBD in kilometers |
| Dist.MMBP | - | straight line distance to Mueng Mai Bang Phli CBD in kilometers |
| Dist.CCS | - | straight line distance to Cha Cheng Sao CBD in kilometers |
| Dist.ST | - | straight line distance to major street in kilometers |
| Dist.BNTHWY | - | straight line distance to Bang Na-Trad highway in kilometers |
| Dist.REC | - | straight line distance to nearest recreation in kilometers |
| Dist.BCACC | - | straight line distance to the nearest New Bangkok-Chonburi highway access in kilometers |
| Dist.BEACC | - | straight line distance to the nearest Bangkok Eastern Outer Ring highway access in kilometers |
| Dist.ALS | - | straight line distance to the closet airport link station in kilometers |
| Att.CANAL | - | dummy variable indicates if agricultural land is adjacent to canal (2=yes 1=no) |

# Map of Suvarnabhumi International Airport and Physical Factors

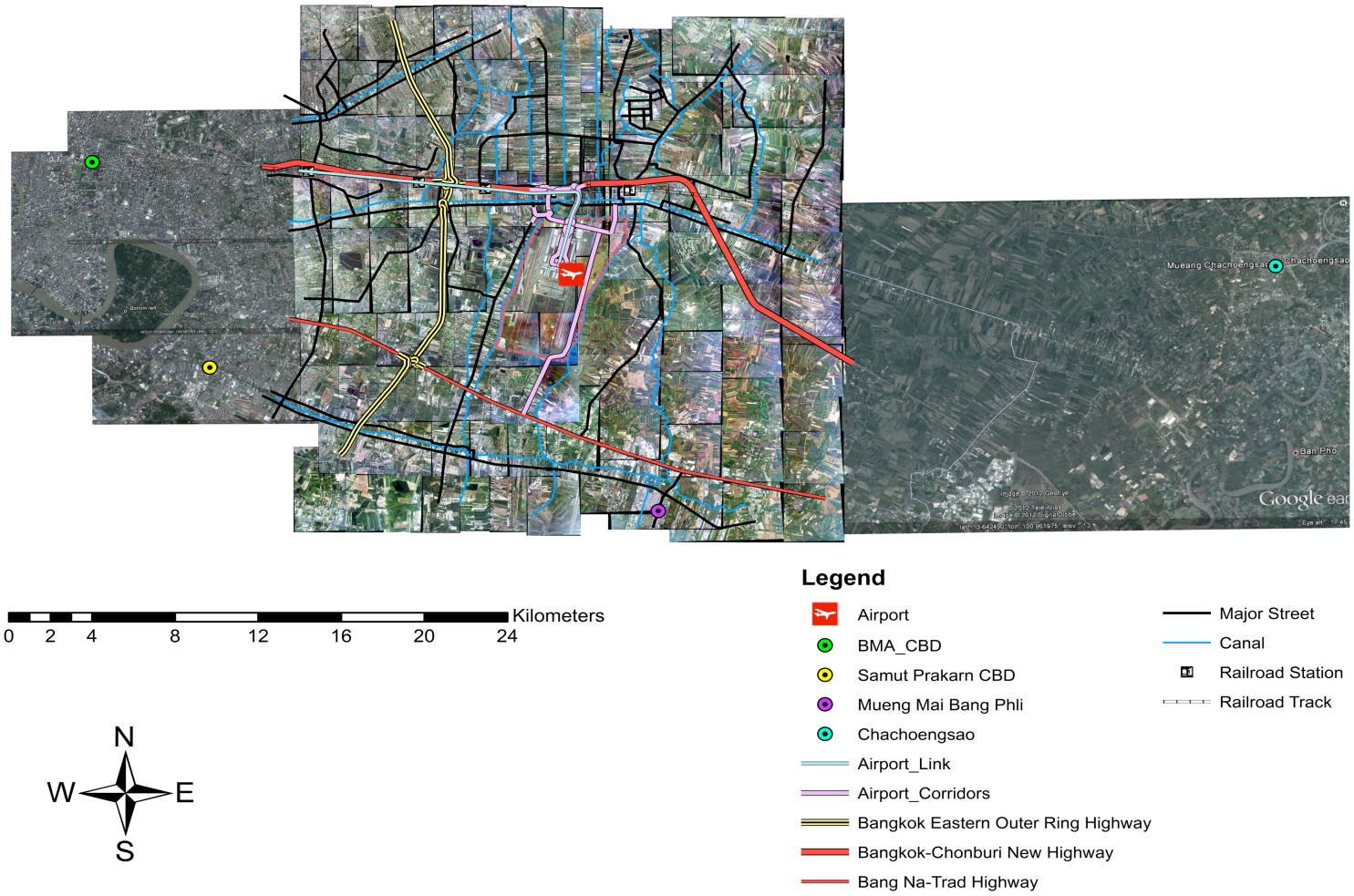



**Figure V.2: Map of Suvarnabhumi International Airport and Physical Factors**

**The Approach of Stepwise Multivariate Urban Land Value Model for an Airport Area**

According to the previous discussion, the stepwise multivariate urban land value model is appropriate to be used to examine the significant level of other variables that have impacts on the land value assessment rather than the airport itself. The model of stepwise multivariate urban land value will determine the significant factors, which influence the value of land around the airport area for six different types of land use (agriculture, commercial, high-density residential, low-density residential, manufacturing & warehouse, and vacant land) within four different quadrants (northwest, northeast, southwest, and southeast), and four different time periods (1987, 1995, 2002, and 2009). The six models of six types of land use by each quadrant and each year are all in the following function form:

$$LV_i = f(PhyFactor) \qquad \text{Equation 5.9}$$

where LV is land value assessment, i is a type of land use, PhyFactor is the physical factor, which include all access to various factors, such as airport, CBDs, major streets, highway accesses, and airport link stations, and amenities, which is the distance to all recreation, such as park, canals, and golf courses.

By substituting those variables into the model, the model with respected relationship is as follows:

$$LV_i = \alpha + \beta_1(Dist.AIR) + \beta_2(Dist.CBD) + \beta_3(Dist.SMP) + \beta_4(Dist.MMBP) + \beta_5(Dist.CCS) + \beta_6(Dist.ST) + \beta_7(Dist.BNTHWY) + \beta_8(Dist.BCACC) + \beta_9(Dist.BEACC) + \beta_{10}(Dist.REC) + \beta_{11}(ATT.CANAL) + \beta_{12}(Dist.ALS) + \varepsilon$$

Equation 5.10

where LV is land value assessment; i is a type of land use; Dist.CBD is the distance to Bangkok CBD; Dist.SMP is the distance to Samut Prakarn CBD; Dist.MMBP is the distance to Muang Mai Bang Phli district; Dist.CCS is the distance to Cha Cheng Sao province CBD; Dist.ST is the distance to the closest major streets; Dist.BNTHWY is the distance to the closest Bang Na-Trad Highway; Dist.BCACC is the distance to the nearest Bangkok-Chonburi New Highway Accesses; Dist.BEACC is the distance to the nearest Bangkok Eastern Outer Ring Highway Accesses; Dist.REC is the distance to the nearest recreations; Att.CANAL is the dummy variable (1 and 0) which represent the group of land parcels that attach to canals; Dist.ALS is the distance to the nearest airport link stations; $\alpha$ is a constant to represent the value that intercepts at the Y-axis; $\beta_1, \beta_2, \ldots\ldots, \beta_{12}$ are the regression coefficients which represent the slope of the plane in the direction of its variable, respectively; and $\varepsilon$ is the error term.

In urban and real estate economic literature, it is common to assume that the relationship between dependent and independent variables is non-linear. The form of the log transformation is more appropriate for the analysis of the multivariate urban land value and multivariate housing value model according to the previous studies (Yeates, 1965; Nelson, 1980, 2003; Asabere, 1981; Ferguson, 1984; Peiser, 1987; Debrezion, Pels, and Rietveld, 2003; McMillen, 2004; Rahmatian, and Cockerill, 2004; Kim, Park, and

Kweon, 2007; Ahlfeldt, and Maennig, 2007; Cebula, 2009). Therefore, the log transformation will be applied to both sides of the equation in order to reduce the value of residuals. The log transformation equation is represented in the function form as follows:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.AIR) + \beta_2 ln(Dist.CBD) + \beta_3 ln(Dist.SMP) + \beta_4 ln(Dist.MMBP) + \beta_5 ln(Dist.CCS) + \beta_6 ln(Dist.ST) + \beta_7 ln(Dist.BNTHWY) + \beta_8 ln(Dist.BCACC) + \beta_9 ln(Dist.BEACC) + \beta_{10} ln(Dist.REC) + \beta_{11} (ATT.CANAL) + \beta_{12} ln(Dist.ALS) + \varepsilon$$

Equation 5.11

Stepwise multivariate regression analysis then will be used with this equation. Therefore, the results of the only significant variables will enter into the model. On the other hand, the non-significant variables will be removed from the equation.

In the stepwise multivariate analysis, the difference of quadrants and years also affects the independent variables in the model. In each quadrant, the model will include 6 equations of 6 types of land use, and in each land use type there are 4 different types of equation based on period of times. Therefore, the total number of equations in each quadrant is 24. With 4 quadrants, the overall number of equations of the stepwise multivariate regression will exceed 96 equations.

**Northwest and Southwest Quadrant: Stepwise Multivariate Analysis**

For the northwest and southwest quadrant, 10 independent variables available for the analysis (Dist.AIR, Dist.CBD, Dist.SMP, Dist.ST, Dist.BNTHWY, Dist.REC, Dist.BCACC, Dist.BEACC, Dist.ALS, Att.CANAL). These 10 variables variable will be

used to explain the impact of the land value assessment for different types of land use. However, not all of the variables will be included in the model because of the availability of the data for different periods of time. In 1987, the 6 models for different types of land use included only 6 response variables for agriculture land use and 5 variables, excluding Att.CANAL, for others. The reason that the Att.CANAL variable included only agriculture land use is because of the usage of the canal for irrigation. Then equation for this period of time is:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.CBD) + \beta_2 ln(Dist.SMP) + \beta_3 ln(Dist.ST) + \beta_4 ln(Dist.BNTHWY) + \beta_5 ln(Dist.REC) + \beta_6(ATT.CANAL) + \varepsilon$$

Equation 5.12

The analysis of this period of time will examine the impact of the others variable on the land value before the new airport was proposed. Then the distance to the airport is not included in the equation because the Thai government proposed the site of the Suvarnabhumi International Airport in 1991. Therefore, this variable should not be included in the model for 1987.

For the stepwise multivariate urban land value model 1995, the models of the northwest and southwest quadrants are similar to the model of 1987, except one variable, the distance to the airport, has been included in the model. Since the Thai government proposed the exact site to construct Suvarnabhumi International Airport in 1991, the local businesses and real estate developers supported it enthusiastically. That caused developers to speculate on the land around the airport. As a result, the distance to the airport may become an important factor to impact the land value around the airport, and

the distance to the airport cannot be ignored in the model. The equation of the stepwise multivariate analysis of 1995 is:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.AIR) + \beta_2 ln(Dist.CBD) + \beta_3 ln(Dist.SMP) + \beta_4 ln(Dist.ST) + \beta_5 ln(Dist.BNTHWY) + \beta_6 ln(Dist.REC) + \beta_7(ATT.CANAL) + \varepsilon \quad \text{Equation 5.13}$$

Similarly to 1987, the ATT.CANAL will be used in the model only for the agriculture land use, and it will be ignored for the other land use types.

In 2002, other accessibility variables, which are Distance to New Bangkok-Chonburi Highway Access and Distance to Bangkok Eastern Outer Ring Highway Access, were added to the model. According to the Sixth Five-Year National Economic and Social Development Plan (1987-1991), the Thai Government specified promotion of the Eastern Seaboard Development Plan to construct the New Bangkok-Chonburi Highway to connect between Greater Bangkok and Southeastern region of Thailand. This project was begun in 1994 and finished in 1998. Also, this project was built to promote the decentralization of economic functions that would contribute to easing the over-concentrated conditions in the Bangkok Metropolitan Area. Moreover, the proposed Bangkok Eastern outer Ring Highway was to build a road to link northern Bangkok with Eastern Seaboard region. Since the project was finished in 1998, there are the impacts of the land values, especially for the manufacturing and warehouse land use. Therefore, these two variables should be included in the model for 2002. The stepwise multivariate equation represents in the following form:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.AIR) + \beta_2 ln(Dist.CBD) + \beta_3 ln(Dist.SMP) + \beta_4 ln(Dist.ST) + \beta_5 ln(Dist.BNTHWY) + \beta_6 ln(Dist.BCACC) + \beta_7 ln(Dist.BEACC) + \beta_8 ln(Dist.REC) + \beta_9 (ATT.CANAL) + \varepsilon$$

Equation 5.14

Finally, in year 2009, the stepwise multivariate equation the distance to Airport Link station, is the final variable.. The Airport Link project is an elevated train to connect Bangkok CBD and Suvarnabhumi International Airport. The construction began in July 2005 and finished in Aug 2010. There are 8 stations from Suvarnabhumi international Airport to Phaya Thai Station. During the construction, developers speculated on the land around the Airport Link stations for real estate and business development. Therefore, the stepwise multivariate equation for this period of time is represented in the following form:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.AIR) + \beta_2 ln(Dist.CBD) + \beta_3 ln(Dist.SMP) + \beta_4 ln(Dist.ST) + \beta_5 ln(Dist.BNTHWY) + \beta_6 ln(Dist.BCACC) + \beta_7 ln(Dist.BEACC) + \beta_8 ln(Dist.REC) + \beta_9 (ATT.CANAL) + \beta_{12} ln(Dist.ALS) + \varepsilon$$

Equation 5.15

**Northeast and Southeast Quadrant: Stepwise Multivariate Analysis**

For the northeast and southeast quadrants, the stepwise multivariate analyses are similar to the northwest and southwest. However, there are a few different variables that are in and out of the equation. Since the two quadrants are far away from the impact of Samut Prakarn CBD, the equations for these two quadrants will ignore the Dist.SMP from the equations. On the other hand, there are two new variables included in the equations - the distance to Muang Mai Bang Phli and Cha Cheng Sao CBD. These two variables are the distance to the CBD for both quadrants, while the CBD of Muang Mai Bang Phli is in the southwest quadrant, and the CBD of Cha Cheng Sao Province is relatively close to the Northeast Quadrant. Therefore, those two variables will be included in the equations of these two quadrants for all 4 different periods of time. The equation of these quadrants will be represented in the following equation:

$$ln(LV_i)=\alpha + \beta_1 ln(Dist.AIR) + \beta_2 ln(Dist.CBD) + \beta_3 ln(Dist.MMBP) + \beta_4 ln(Dist.CCS) + \beta_5 ln(Dist.ST) + \beta_6 ln(Dist.BNTHWY) + \beta_7 ln(Dist.BCACC) + \beta_8 ln(Dist.BEACC) + \beta_9 ln(Dist.REC) + \beta_{10}(ATT.CANAL) + \beta_{11} ln(Dist.ALS) + \varepsilon \quad \text{Equation 5.16}$$

Similarly to the northwest and southwest quadrants, the equation of the year 1987 will not include the distance to the airport (Dist.AIR), which will be included in the equations for 1995, 2002, and 2009. In addition, the distance to the New Bangkok-Chonburi Highway (Dist.BCACC) and the distance to Bangkok Eastern Outer Ring Highway (Dist.BEACC) will be included in the equations for 2002 and 2009. Finally,

the distance to the Airport Link station will be included in the equations only for the year 2009.

# CHAPTER VI

## INTERPRETATION OF THE ANALYSIS AND EMPIRICAL RESULTS OF AIRPORT ECONOMIC RENTS

This section presents two discussions relating to two research questions posed earlier that address the following issues: whether land values for each type of land use activities have been affected by proximity to the designated airport location within different quadrants and time periods; how the urban land market around the airport allocates for different periods of time according to the urban land use theory; if there are price impacts, what is the timing of these impacts; and whether any factors impact the land values other than proximity to the designated airport location, and how these factors impact the prices of land.

### Interpretation of the Empirical Results by Quadrant

The discussion of the empirical results divides the study area into four quadrants - northwest, northeast, southwest, and southeast. Within each quadrant the discussion will focus on the results of two models, the bid-rent model and the stepwise multivariate regression analysis. In terms of the bid rent model, the results will explore the impact of the airport on the six types of land use without the exogenous factors. Next, the discussion will center on the results of the stepwise multivariate regression analysis of six types of land use to determine whether other factors have impact on changing , the prices of land.

#### Northwest Quadrant

The first discussion of the results of the bid-rent model and the stepwise multivariate regression analysis concerns the area in the northwest quadrant. Most of the area is in Bangkok City, which includes some part of Saphan Sung District, Bueng Kum

District, Bang Kapi District, Wang-Thong Lang District, Suan Luang District, Prawet District, Min Buri District, and Lat Krabang District. The discussion focuses on the impact of the airport on the six different types of land values throughout the period prior to the existence of an airport development plan (1987), the period after proposed airport site (1995), the period of airport construction (2002), and the period after the opening of the airport (2009).

**Table VI.1: Log Linear Regression for Parameters of Bid-Rent Function, Northwest Quardrant**

| Land Use | 1995 | | | 2002 | | | 2009 | | |
|---|---|---|---|---|---|---|---|---|---|
| | b | t | F | b | t | F | b | t | F |
| **Agriculture** | 0.179 | 2.077 | 4.312 | | | | | | |
| **Low-Density Residential** | 0.798 | 16.269 | 264.693 | 0.555 | 11.423 | 130.393 | 0.436 | 9.709 | 94.262 |
| **High-Density Residential** | 0.587 | 4.975 | 24.747 | 0.383 | 5.621 | 31.388 | 0.326 | 4.784 | 22.766 |
| **Commercial** | 0.891 | 8.360 | 69.886 | 0.529 | 8.039 | 64.626 | 0.483 | 7.280 | 53.148 |
| **Manufacturing & Warehouse** | 0.482 | 5.552 | 30.828 | 0.431 | 7.154 | 51.174 | 0.394 | 6.982 | 48.747 |
| **Vacant Land** | 0.727 | 10.315 | 106.396 | 0.435 | 7.673 | 58.870 | 0.427 | 6.769 | 45.821 |

$\alpha$ = 5 percent level

Dependent variable is LN(Land Value)

Independent variable is LN(Distance to Airport)

**Table VI.2: Results of Stepwise Log Linear Multiple-Regression on Land Value by Land Use Type and Year, Northwest Quadrant**

| Land Use / Variable | Agriculture | | | | L-Density Residetial | | | | H-Density Residential | | | | Commercial | | | | Manufacturing & Warehouse | | | | Vacant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 |
| 1. Dist.AIR | | -1.033 | -0.599 | | | -0.395 | | | | -0.552 | | -0.355 | | -1.182 | | -0.529 | | -0.879 | | -0.378 | | -0.540 | -0.171 | |
| | | (-9.326) | (-6.346) | | | (-4.949) | | | | (-3.126) | | (-2.949) | | (-5.533) | | (-4.710) | | (-7.736) | | (-3.350) | | (-5.310) | (-2.363) | |
| 2. Dist.CBD | -0.822 | -3.836 | -1.061 | -0.700 | -1.734 | -2.869 | -1.053 | -1.007 | -2.180 | -2.965 | -1.208 | -1.752 | -2.692 | -4.894 | -1.600 | -2.350 | -1.893 | -3.555 | -1.023 | -2.042 | -1.822 | -3.682 | -1.656 | -1.334 |
| | (-4.772) | (-13.438) | (-7.219) | (-2.915) | (-13.726) | (-17.856) | (-11.375) | (-12.668) | (-6.452) | (-8.642) | (-10.114) | (-7.661) | (-8.232) | (-10.946) | (-14.460) | (-11.007) | (-11.522) | (-14.992) | (-11.076) | (-6.713) | (-12.551) | (-15.095) | (-13.201) | (-13.110) |
| 3.Dist.SMP | | | | | | | | | | 0.918 | | | | | | | | | | 0.732 | -0.451 | 0.864 | | |
| | | | | | | | | | | (4.011) | | | | | | | | . | | (3.776) | (-3.896) | (5.658) | | |
| 4. Dist.ST | -0.416 | -0.316 | -0.369 | -0.328 | -0.243 | -0.150 | -0.250 | -0.154 | -0.299 | -0.259 | -0.232 | -0.242 | -0.315 | -0.386 | -0.307 | -0.309 | -0.300 | -0.413 | -0.438 | -0.102 | -0.372 | -0.377 | -0.340 | -0.345 |
| | (-20.907) | (-12.742) | (-19.026) | (-10.413) | (-11.267) | (-8.827) | (-15.589) | (-9.591) | (-7.021) | (-8.694) | (-10.381) | (-9.673) | (-5.342) | (-9.586) | (-13.010) | (-14.184) | (-9.063) | (-17.206) | (-27.218) | (-4.236) | (-22.862) | (-22.890) | (-24.225) | (-22.397) |
| 5. Dist.BNTHWY | -0.477 | 0.589 | | -0.216 | | 0.406 | 0.091 | | | | | | -0.336 | 0.607 | -0.231 | -0.134 | | 0.452 | | | | | | |
| | (-5.931) | (5.155) | | (-2.009) | | (6.413) | (2.095) | | | | | | (-2.841) | (4.433) | (-3.944) | (-1.838) | | (4.590) | | | | | | |
| 6. Dist.REC | | -0.201 | -0.137 | | -0.159 | -0.170 | -0.101 | | | -0.098 | | | 0.164 | | 0.070 | | | | | | | -0.173 | | -0.126 |
| | | (-4.190) | (-3.692) | | (-5.259) | (-6.618) | (-4.509) | | | (-2.337) | | | (2.073) | | (2.170) | | | | | | | (-5.024) | | (-4.159) |
| 7. Att.CANAL | -0.219 | -0.212 | | | | | | | | | | | | | | | | | | | | | | |
| | (-3.899) | (-3.467) | | | | | | | | | | | | | | | | | | | | | | |
| 8. Dist.BCACC | | | 0.231 | | | | 0.158 | 0.124 | | | 0.132 | | | | | 0.194 | | | 0.148 | 0.248 | | | 0.221 | 0.107 |
| | | | (5.747) | | | | (5.411) | (4.549) | | | (2.775) | | | | | (4.580) | | | (4.607) | (5.561) | | | (6.060) | (3.489) |
| 9. Dist.BEACC | | | | | | | | 0.060 | | | | | | | | -0.086 | | | | | | | | |
| | | | | | | | | (3.449) | | | | | | | | (-3.186) | | | | | | | | |
| 10. Dist.ALS | | | | | | | | | | | | 0.235 | | | | | | | | | | | | |
| | | | | | | | | | | | | (3.903) | | | | | | | | | | | | |
| Constant | 9.698 | 18.710 | 12.257 | 10.685 | 11.585 | 15.439 | 11.525 | 11.821 | 12.953 | 14.628 | 12.434 | 14.615 | 15.205 | 22.271 | 14.299 | 17.202 | 12.269 | 18.039 | 11.413 | 13.623 | 12.801 | 16.231 | 13.449 | 12.455 |
| F-Statistic | 140.101 | 76.576 | 81.204 | 46.892 | 164.625 | 184.217 | 98.685 | 75.683 | 42.477 | 44.232 | 69.276 | 46.707 | 30.670 | 83.835 | 105.427 | 99.101 | 113.299 | 164.581 | 310.753 | 29.290 | 280.237 | 227.003 | 207.149 | 170.269 |
| Adjusted $R^2$ | 0.472 | 0.478 | 0.468 | 0.294 | 0.381 | 0.450 | 0.313 | 0.197 | 0.401 | 0.381 | 0.365 | 0.330 | 0.442 | 0.555 | 0.584 | 0.630 | 0.434 | 0.539 | 0.607 | 0.185 | 0.438 | 0.489 | 0.437 | 0.429 |
| Sample Size | 623 | 497 | 456 | 332 | 799 | 1119 | 1073 | 1222 | 125 | 352 | 357 | 372 | 151 | 267 | 299 | 346 | 294 | 561 | 603 | 626 | 1074 | 1181 | 1064 | 904 |

Note: Significant at 5 percent level

Variables 1. Distance to Airport (Dist.AIR), 2. Distance to Bangkok CBD (Dist.CBD), 3. Distance to Samut Prakarn CBD (Dist.SMP), 4. Distance to Nearest Major Street (Dist.ST)
5. Distance to Bang Na-Trad Highway (Dist.BNTHWY), 6. Distance to Recreation (Dist.REC), 7. Attach to Canal (ATT.CANAL), 8. Distance to Bangkok-Chonburi New Highway Access (Dist.BCACC)
9. Distance to Bangkok Eastern Outer Ring Highway Access (Dist.BEACC), 10 Distance to Airport Link Station (Dist.ALS)

Model: * 1987, Variables include Variable 2-7 * 1995, Variables include Variable 1-7 * 2002, Variables include Variable 1-9 * 2009, Variables include Variable 1-10

Agricultural Land

**Bid-rent model (simple regression analysis).**

The results of the bid rent model for the northwest quadrant of the airport are shown in table 6.1. The analysis indicates that the distance to the airport has an impact on the agriculture land value only for the year 1995. The outcome of the analysis of the variance (table VI.1) shows that the F-value is 4.312, with 1 and 496 degrees of freedom, which is greater than the critical F-value at 5 percent level (3.8415). Therefore, the log linear regression equation, in which the parameter estimate of the distance to airport variable is not equal to zero, is significant.

Moreover, the result of the positive regression coefficient of the natural log of Dist.AIR explains the positive relationship between the natural log of Dist.AIR and the natural log of average land value, which has a coefficient 0.179, t-statistic 2.077, and p-value of0.038. Therefore, the result of the regression coefficient is significant to reject the null hypothesis that the slope of Dist.AIR is not equal to zero.

Since the regression is a double natural log transformation, the result of the elasticity of the natural log indicates that increasing the distance to the airport by 1 percent in 1995 would increase the price of agricultural land by 18 percent. However, the sign of the coefficient in the equation shows the positive relationship, which is different from the hypothesis. That means the agricultural land value for 1995 may be influenced not only by the distance to the airport, but also by other factors as well.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.2, the results of the stepwise multivariate regression analysis of four periods of time (1987, 1995, 2002, and 2009) indicate the significance of

the models at the 5 percent level. Considering the adjusted R-squared values, the results of adjusted R-square of four periods of time are 0.472, 0.478, 0.468, and 0.294. These values indicate that the independent variables of each time period have a statistical relationship with the agriculture land value in the northwest quadrant.

The 1987 equation examines the factors that impacted the agriculture land value before the airport was proposed. Without the airport, six independent variables enter into the equation. These six variables include: the distance to The Bangkok CBD (Dist.CBD), the distance to Samut Prakarn CBD (Dist.SMP), the distance to major streets (Dist.ST), the distance to Bang Na-Trad Highway (Dist. BNTHWY), the distance to recreational areas (Dist.REC), and the dummy variable of land that attaches to the canal (ATT.CANAL). The final step of the regression of the 1987 model shows that only four independent variables are negatively significant: Dist.CBD, Dist.ST, Dist.BNTHWY, and Att.CANAL. Among these four variables, the average agriculture land value is most sensitive to the distance to Bangkok CBD rather than others variables with the coefficient of -0.822 and t-statistic of -4.772. The result suggests that with an increase of 1 percent from the Bangkok CBD, the average land value of agriculture land will decrease by about 82.20 percent.

The second important variable is Dist.BNTHWY with the coefficient of -0.477 and t-statistic of -5.931. The result suggests that the average agriculture land value will decrease about 47.70 percent when the distance is 1 percent farther away from the Bang Na-Trad Highway. The third variable that has impact on the agriculture land value is Dist.ST, while the coefficient of this variable is -0.416 and t-statistic is -20.907. The result suggests that the price of the agricultural land will decrease about 41.60 percent

when the distance to the major streets increases 1 percent. Finally, the least sensitive variable affecting the agriculture land value is Att.CANAL, with the coefficient of -0.219 and t-statistic of -3.899. The result suggests that the price of agriculture land that attaches to canals will decrease by about 21.90 percent when it is 1 percent farther away from the canals.

The 1995 equation considers the impact of the beginning of the new airport four years after it was proposed in 1991. With the proposed site, seven independent variables are included into the equation - the six independent variables from the 1987 model plus one new variable, which is the distance to the airport variable. The result of the final step of stepwise regression indicates that six of seven variables are significant, including Dist.AIR, Dist.CBD, Dist.ST, Dist.BNTHWY, Dist.REC, and Att.CANAL. Among these significant variables, the Dist.CBD is still the most important factor to affect the price of agricultural land rather that the Dist.AIR and other accessibility variables with the coefficient of -3.836, and the t-statistic of -13.438. This result suggests that in 1995 the price of agricultural land might decrease by about 383.60 percent with a 1 percent increase of the distance from the Bangkok CBD. The high rate of change in the agricultural value may be affected by the rapid growth in the core area and the high price of land in the core area.

The second important variable that affects the agriculture land value is the Dist.AIR with the coefficient of -1.033 and t-statistic of -9.326. The result suggests that increasing the distance to the airport by 1 percent will cause the price of agriculture land to decrease 103.3 percent. The third important variable is the Dist.BNTHWY. The interpretation of the result of this variable provides a positive impact on the land value,

which is different for the hypothesis of the study, by increasing the value of agriculture land about 58.90 percent when it is moved farther away from the Bang Na-Trad Highway by 1 percent. This positive sign may be affected by the other significant variables in that time period.

The next significant variable is the Dist.ST. The result of the model indicates that the coefficient of Dist.ST is -0.316 with t-statistic of -13.438, which means the average agriculture land value will decrease about 31.60 percent with an increase of the distance from the major streets by 1 percent. Finally the two less important variables affecting the price of agriculture land are Att.CANAL and Dist.REC with the coefficients of -0.212 and -0.201, and the t-statistics of -3.467 and -4.190. These two independent variables have the same impact on the agricultural land value with increasing the distance to recreational areas and canals by about 1 percent. This will decrease agricultural land value by about 21 percent.

During the period of airport construction, two new highways were built to support the use of the airport. One connects the northern Bangkok region and Samut Prakarn province (Bangkok Eastern Outer Ring Highway), and the other connects the greater Bangkok region and the eastern region (Bangkok-Chonburi New Highway). These two new independent variables will be included in the equations as Dist.BCACC and Dist.BEACC. The final step of the stepwise regression indicates that five of the nine independent variables are significant, including Dist.AIR, Dist.CBD, Dist.ST, Dist.REC, and Dist.BCACC. The most sensitive variable affecting the price of agriculture in this time period is still the same from the previous time period, which is Dist.CBD. The result indicates the significance of the coefficient of -1.061 and t-statistic of -7.219,

which means the price of the land will decrease by 106.10 percent with an increase of 1 percent in the distance from the Bangkok CBD.

The second sensitive factor on the land value is the Dist.AIR with the coefficient of -0.599 and the t-statistic of -6.346. The result suggests that the price of agricultural land will decrease about 59.90 percent with an increase of 1 percent distance from the airport. For the next sensitive variable, the Dist.ST has less impact on the agricultural land value than the first two variables with the coefficient of -0.369 and t-statistic of -6.346. The interpretation of the results suggests that the price of agriculture land will decrease 36.90 percent with an increase in distance of 1 percent from major streets. The fourth important variable is the Dist.BCACC with the positive significant coefficient of 0.231 and the t-statistic of 5.747, which is opposite to the hypothesis of the dissertation. Since the result is positively significant, this suggests that the agricultural land value will increase 23.10 percent with an increasing distance of 1 percent from the closest highway access. The least significant factor impact on the agricultural land value is the Dist.REC with the coefficient of -0.137 and the t-statistic of -3.692. The result suggests that recreational areas around the airport in the northwest quadrant will have impact on the land value by decreasing the price of land about 13.70 percent with the increase of 1 percent in distance from the nearest recreation.

The final model of agricultural land value of the northwest quadrant is the2009 model, which focuses on the impact of the airport after it opened. There are ten variables included in the equation with one new variable, which is the distance to the nearest airport link station. The result of the final step of stepwise regression indicates that three of ten independent variables are negatively significant, which include Dist.CBD, Dist.ST

and Dist.BNTHWY. The most important variable that affects the change in agriculture land value is Dist.CBD. The result suggests that the agriculture land value will decrease about 70 percent with an increase in the distance by 1 percent from the Bangkok CBD, while the coefficient of this variable is -0.700 and the t-statistic is -2.915. The second important variable is the Dist.ST with the coefficient of -0.328 and t-statistic of -10.413. That means the price of agricultural land will decrease 32.8 percent with an increase of 1 percent in the distance from the major streets.

Finally, the least important explanatory variable in the equation affecting the change in land price is Dist.BNTHWY. The result indicates the coefficient of the variable with -0.216 and the t-value of -2.009, which means the distance to the Bang Na-Trad Highway is sensitive to the agriculture land value by decreasing about 21.60 percent with the increase by 1 percent in distance from the Bang Na-Trad Highway. However, the distance to the airport for year 2009, after the opening of the airport, seems not to have had an impact on the agricultural land value. This result may be an effect of the economic crisis, which slowed down demand for land around the airport. Also, because land values were overpriced based on the actual selling price before the period of financial crisis, the Bureau of Property Evaluation, the Treasury Department, and Ministry of Finance adjusted the land value to the actual selling price in 2005. This may have caused the agricultural land value in the northwest quadrant to become insensitive to the distance to the airport. Moreover, the significance of the three variables in this time period may play a more important role in changing land values than the distance to the airport.

Low-Density Residential Land

**Bid-rent model (simple regression analysis).**

The second model of bid-rent uses the natural log of average low-density residential land values for 1995, 2002, and 2009 as the dependent variables. The natural log of Dist.AIR variable for each year enters into the equation. The results of the three bid-rent models for different periods of time are shown in table VI.1. The results of the F-statistic show that the three models, in which all three parameter estimates are not equal to zero, are significant. The F-values of the three models for year 1995, 2002, and 2009 are 264.693, 130.393, and 94.262 respectively, which are significant at the 5 percent level.

In addition, the results of the regression coefficient of the natural log of Dist.AIR for all three models are positively significant related to the natural log of the commercial land value. For 1995, 2002, and 2009, the coefficients of the natural log of Dist.AIR are 0.798, 0.555, and 0.436, while the t-statistics are 16.269, 11.423, and 9.709. These t-statistics indicate the significance of the slope, which is not equal to zero at the significance of 5 percent level. The comparison of the slopes of the three models shows that the bid-rent curves have more slope in 1995 and are less steep over the time periods in 2002 and 2009.

On the other hand, the significance of the positive sign of three coefficients is opposite to the hypothesis, which should be negative. Therefore, the results of these positive coefficients indicate that the farther away from the airport, the higher land value. Also, other factors may impact the average of low-density land values rather than the

airport itself in the northwest quadrant, which may cause the different in the sign of those three coefficients.

**Hedonic pricing model (multivariate regression analysis).**

The results of stepwise multivariate regression analysis of average low-density residential land value for four periods of time (1987, 1995, 2002, and 2009) are shown in table VI.2. The results of the stepwise regression models indicate the significance of the model at 5 percent level, while the adjusted R-squares of four periods of time are 0.381 (1987), 0.450 (1995), 0.313 (2002), and 0.197 (2009). This means the average of low-density residential land value can be explained as about 38 percent for 1987, 45 percent for 1995, 31 percent for 2002 and 20 percent for 2009, all by significant independent variables in the equation of each year.

Considering the 1987 model, the period before the airport, the five independent variables included in the equation are Dist.CBD, Dist.SMP, Dist.ST, Dist.BNTHWY, and Dist.REC. The result of the final step of the stepwise regression model indicates that three of the five variables are negatively significant at the 5 percent level in order to explain the change in average low-density residential land values, which include Dist.CBD, Dist.ST, and Dist.REC. The most important factor that impacts low-density residential land values is the Dist.CBD with the coefficient of -1.734, and t-statistic of -13.726. The results suggest that the average of low-density residential land values will decrease about 173.4 percent with an increasing distance from The Bangkok CBD of 1 percent. The second important variable that has impact on the price of low-density residential land is the Dist.ST with the coefficient of -0.243 and t-statistic of -11.267. This result demonstrates that the average value of low-density residential land will

decrease about 24.3 percent when moved farther away from the Bangkok CBD for every 1 percent. Finally, the least significant factor is the Dist.REC variable. The result shows the coefficient of -0.159 with t-statistic of -5.259, which means the price of low-density residential land will decrease only 15.9 percent for every 1 percent increase in the distance from nearest recreational area.

Next, the 1995 stepwise regression model contains six independent variables, which include the Dist.AIR. The result of the final step of stepwise regression indicates that five of the six independent variables are significant, which include Dist.AIR, Dist.CBD, Dist.ST, Dist.BNTHWY, and Dist.REC. Among these five significant variables, the order of the effect of these variables on the low-density residential land value is Dist.CBD (-2.869), Dist.BNTHWY (0.406), Dist.AIR (-0.395), Dist.REC (-0.170), and Dist.ST (-0.150). As a result, the average of low-density residential land value will be most sensitive to the distance to the Bangkok CBD. Land values decrease by about 286.9 percent for every 1 percent they are moved farther away from the Bangkok CBD. This can be compared with the third and fourth most important influence factors by which the average values of low-density residential land decrease only 39.5 percent and 17 percent with every 1 percent increase in distance from the airport and distance to the nearest recreation.

Another result, the second most important factor, which is the Dist.BNTHWAY, has the opposite sign of coefficient from the hypothesis of this dissertation. The interpretation is that an increase of 1 percent in the distance from the Bang Na-Trad Highway will increase the average values of low-density residences by 40.6 percent. Since 1995 is the year after the proposing of the airport site, the market was reacting to

the announcement of the new airport site, and that caused the value of low-density residential land closer to the airport to increase dramatically. By combining the three negatively significant variables, it is possible to cause the change in the sign of the coefficient of the Dist.BNTHWY variable.

Moreover, the result of the final step of stepwise regression model (the 2002 model) for the period of construction of the new airport indicates that five of the nine independent variables are significant. These variables include Dist.CBD, Dist.ST, Dist.BNTHWY, Dist.REC, and Dist.BCACC. The coefficients of all the important five independent variables are: Dist.CBD (-1.053), Dist.ST (-0.250), Dist.BCACC (0.158), Dist.REC (-0.101), and Dist.BNTHWY (0.091). As a result, the average low-density residential land value is most sensitive to the distance to the Bangkok CBD rather than the other four variables. The result suggests that the price of the low-density residential land will decrease by 105.3 percent for every 1 percent increase in the distance from the Bangkok CBD. Compared to the second important variable, Dist.ST, the result shows a small change in the price of the land, which decreases by about 25 percent for every 1 percent increase in the distance from the nearest major street.

The third important variable affecting the low-density residential land value is the distance to the new Bangkok – Chonburi highway access. The result shows a positive significant coefficient, which is opposite to this dissertation's hypothesis. The interpretation of the result is that the price of the low-density residential land will increase by 15.8 percent as the distance to the nearest access of New Bangkok-Chonburi highway increases by 1 percent. The next important variable is the Dist.REC. The result suggests that the price of low-density residential land will decrease slightly by about 10

percent as the distance to the nearest recreation increases by 1 percent. Finally, the least important variable affecting the low-density residential land value is Dist.BNTHWY. Similar to the Dist.BCACC, the result of the final step of the stepwise regression indicates the positive significance for this variable. This means an increase of 1 percent in the distance from the Bang Na-Trad highway will cause only a 9 percent increase in the price of land.

The last model of the stepwise regression is the model for the year 2009, which contains nine variables. The results of the stepwise regression model indicate that only four independent variables, Dist.CBD, Dist.ST, Dist.BCACC, and Dist.BEACC, are significant for this time period. The most important variable influencing the low-residential land value is the Dist.CBD with the coefficient of -1.007. This result indicates that the average low-density residential land value is the most sensitive to the distance to The Bangkok CBD compared to the other three influential variables. This means the price of land will decrease about 100.7 percent as the distance to the Bangkok CBD increases by 1 percent.

The second important variable is the Dist.ST with the coefficient of -0.154 and the t-statistic of-9.591. The result reveals that the price of low-density residential land will decrease by only 15.4 percent as the distance to the nearest major streets increases by 1 percent. The third and fourth important variables, which are Dist.BCACC and Dist.BEACC, are positively significant with the coefficient of 0.124 and 0.060. The results of both variables are opposite to the hypothesis of this dissertation. However, both results suggest that the price of low-density residential land will increase about 12.4 and

6 percent as the distance from the nearest access of both highways is increased by 1 percent.

High-Density Residential Land

**Bid-rent model (simple regression analysis).**

According to table VI.1, the results of the three-year models of bid-rent analysis show that the three models are significant at the 5 percent level with the F-value 24.747, 31.388, and 22.766 for the years 1995, 2002, and 2009. That means all three parameter estimates of the natural log of Dist.AIR in the three equations are nonzero. Furthermore, the results of the three regression coefficients for the natural log of the Dist.AIR variable indicate a positive impact on the average land value of high-density residential land. The coefficient of three Dist.AIR variables for 1995, 2002, and 2009 are significant with coefficients of 0.587, 0.383, and 0.326 with the t-statistic of 4.975, 5.621, and 4.784 respectively. The results of the regression coefficients show that the slopes of three variables are not equal to zero. From these results, there are some findings that the Dist.AIR itself has impact on the average high-density residential land value. Second, the steepest slope of bid-rent curve is represented in 1995 and is less steep over the time periods for 2002 and 2009. Third, all three positive coefficients of the natural log of Dist.AIR are different from the hypothesis, which is negative. That means with the increasing in distance to the airport, the average land value of high-density residential land will increase dramatically.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.2, the results of stepwise multivariate regression analysis of the high-density residential land value show significant results of four models (1987,

1995, 2002, and 2009). The F-statistic and adjusted R-square show a moderate relationship between dependent and independent variables in the model, while the adjusted R-square of stepwise regression model for four periods of time are 0.401 (1987), 0.381 (1995), 0.365 (2002) and 0.330 (2009). With the F-statistic of 42.477 (1987), 44.232 (1995), 69.276 (2002), and 46.707 (2009), it is possible to reject the null hypothesis. The results confirm that all parameter estimates in the four models are not equal to zero.

Considering the results of the stepwise regression analysis of the time prior the airport, only two independent variables, Dist.CBD and Dist.ST, are significant. The signs on two coefficients match what was intuitively expected from the hypothesis of this dissertation. Furthermore, the analysis of the coefficients shows that the Dist.CBD and Dist.ST variables are significant at the 5 percent level. As a result, the average high-density residential land value was more sensitive to the distance to The Bangkok CBD than to nearest major streets with the coefficient of -2.180 for Dist.CBD, and -0.299 for Dist.ST. The negative sign on the coefficient for Dist.CBD would imply that the price of the high-density residential land decreases by 218 percent as the distance to the Bangkok CBD increases by 1 percent compared to the Dist.ST. This would imply that the value of the high-density residential land decreases by only 29.90 percent as the distance to the nearest major street increases by 1 percent.

After the airport site was proposed in 1991, the result of the stepwise regression analysis of the year 1995 indicates that five of six independent variables, including Dist.AIR, Dist.CBD, Dist.SMP, Dist.ST, and Dist.REC, are significant at the 5 percent level. The result of the coefficients of four variables; Dist.AIR, Dist.CBD, Dist.ST, and

Dist.RE, shows the negative sign in orders of -0.552, -2.965, -0.259, and -0.098, which is similar to the expectation of the dissertation hypothesis. On the other hand, the positive sign on the coefficient for Dist.SMP variable is opposite to the hypothesis of the study with the coefficient value of 0.918. Among these five significant variables, the average high-density residential land value is the most sensitive to the Dist.CBD variable rather than other significant variables in the equation.

The result of the negative coefficient for Dist.CBD would imply that the price of the high-density residential land decreased by 296.50 percent as the distance to the Bangkok CBD increased by 1 percent. Compared to the coefficients of the second important variable, the average high-density residential land value would increase about 91.8 percent as the distance to Samut Prakarn province CBD increased by 1 percent. Since the land value in Bangkok City is higher than in Samut Prakarn province, the influence of the higher price of land in Bangkok City may affect the change in the positive sign of the coefficient for Dist.SMP. For the rest of the variables, the result indicates the negative sign on all three coefficients. This would imply that the average land value of high-density is decreased by 55% for the Dist.AIR and 25.9% for the Dist.ST, and slightly changes by 9.8% for the Dist.REC as the distance increases by 1 percent from the measurement point of these factors.

During the construction of the airport, the results of the stepwise regression analysis for 2002 indicate that three of eight independent variables, which include Dist.CBD, Dist.ST, and Dist.BCACC, are significant at the 5 percent level. The results of the coefficient of three significant variables are in order of -1.208, -0.232, and 0.132 with t-statistic of -10.114, -10.381, and 2.775. The result indicates that the Dist.CBD will

still be a major factor affecting the price of high-density residential land. That would imply that the average high-density residential land value decreased by 120.8 percent as the distance from the Bangkok CBD increased by 1 percent. Similar to the previous model of 1987 and 1995, the Dist.ST variable provides negative impact on the value of land, which means the price of high-density residential land would decrease by 23.2 percent as the distance to the nearest major streets increases by 1 percent.

The third significant variable affecting the price of land is Dist.BCACC. Although the result of stepwise regression analysis indicates the significance of the variable, the positive sign of the coefficient of this variable is quite different from the expectation of this dissertation. However, the positive sign of the coefficient for Dist.BCACC implies that in 2002 the price of high-density residential land increased by 13.2 percent as the distance to the nearest access of New Bangkok-Chonburi Highway increased by 1 percent. As a result, the lower of the land values close to the access of the highway might be affected by the noise and air pollution from the highway. Also, because of the limited access to the highway, people who live closer to the highway will have a difficult time getting to the highway access because they have to travel farther away using local streets.

During the period after the airport opened, the results of stepwise regression analysis reveal four significant variables at the 5 percent level. These variables include Dist.AIR, Dist.CBD, Dist.ST, and Dist.ALS with the coefficients in order of -0.355, -1.752, -0.242, and 0.235. In this period, the distance to the CBD is the most influential factor with a negative impact that affects the change in the price of high-density residential land. This implies that the price of high-density residential land decreased by

175.2 percent as the distance to the Bangkok CBD increased by 1 percent in 2009. Also, in this period, the airport is the second important factor that affects the price of land by providing the negative impact on the value of high-density residential land. This result suggests that the price of the high-density residential land decreased by 35.5 percent as the distance to the airport increased by 1 percent.

Finally, accessibility to major streets and the airport link elevated train stations also are influential factors affecting the high-density residential land value with a negative impact for the Dist.ST and positive impact for Dist.ALS. One finding affirms the dissertation's expectation that high-density residential land value will increase with direct access to a street network. On the other hand, the positive impact of the accessibility to airport link stations is different from the dissertation's expectation. One explanation of this result is that the land value assessment of 2009 was calculated by collecting the actual land values by the Bureau of Property Evaluation, The Treasury Department from the previous year prior to the operation of the airport-link elevated train. Also, the influence of other significant variables, such as the Bangkok CBD and the accessibility variables, causes the change in the sign on the coefficient of the Dist.ALS variable.

Commercial Land

**Bid-rent model (simple regression analysis).**

Considering the average value of the commercial land corresponding to the distance to the airport for three periods of time (table VI.1), the results of the three models are significant. The F-value of 1995, when the site of the airport was proposed, is 69.886. In 2002, when the airport was under construction, the F-value of the model

indicates the significance at 64.626. Finally, when the airport was opened in 2009, the F-value of the model at that time is 53.148. Since the F-values of these three models are significant, the results suggest rejection of the null hypothesis that the parameter estimates for all three models are not equal to zero.

In terms of the regression coefficient, the results show that all three regression coefficients of the natural log of Dist.AIR are positively significant related to the natural log of average values of commercial land in the area. For 1995, 2002, and 2009, the coefficients of the regression models are 0.891, 0.529, and 0.483, with the significant t-statistic of 8.360, 8.039, and 7.280 respectively. Therefore, the significance of the t-statistics determines that the slopes of all three dependent variables are not equal to zero. As a result, the average commercial land value is sensitive to distance to the airport, while the average commercial land value for 1995 is more sensitive to distance to airport than 2002 and 2009. However, the positive signs of the three coefficients are still different from the hypothesis, which suggests a negative relationship for the Dist.AIR. That means the farther away from the airport, the higher the average commercial land value.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.2, the results of stepwise multivariate regression analysis of the average commercial land value for four periods of time (1987, 1995, 2002, and 2009) indicate the significance of the models at the 5 percent level with the F-statistic in order of 30.670, 83.835, 105.427, and 99.101.At the same time, the adjusted R-squares for four periods of time are 0.442 (1987), 0.555 (1995), 0.584 (2002), and 0.630 (2009), which means the average commercial land value is about 44 percent for 1987, 56 percent for

1995, 58 percent for 2002, and 63 percent for 2009 by all significant independent variables in the equation for each time period.

During the period prior to the construction of the airport, the results of the stepwise regression analysis indicate four significant independent variables, which include Dist.AIR, Dist.ST, Dist.BNTHWY, and DistREC. The results of the coefficients show in the order of -2.692, -0.315, -0.336, and 0.164, while the t-statistics show in the order of -8.232, -5.342, -2.841, and 2.037. The results of the stepwise regression analysis in this time period affirm that the Bangkok CBD is still the most influential factor affecting the price of commercial land. That is because of its agglomeration economies and the privilege of the central business district in downtown Bangkok. The negative sign on the coefficient of Dist.CBD suggests that the price of the commercial land decreased by 269.20 percent as the distance to the Bangkok CBD increased by 1 percent.

Similarly to the Dist.CBD, the proximity to the main street and proximity to Bang Na Trad highway are the second and third most important factors affecting the price of commercial land by decreasing the commercial land value in proportion to the increased distance to the transportation network, such as major streets and the highway. For example, in this time period, the distance to Bang Na-Trad Highway will have impact on the commercial land value more than the distance to the major streets. That means the average commercial land value decreased by 33.60 percent as the distance to Bang Na-Trad highway increased by 1 percent compared to the price of commercial land, which decreased by 31.50 percent as the distance to the nearest major street increased by 1 percent. Also, the result indicates the positive impact of the Dist.REC on the commercial

land value. This means that, when the distance to the nearest recreation increases by 1 percent, it will increase commercial land value by 16.4 percent.

The results of the period after the airport site was proposed (1995) indicate that four independent variables, which include Dist.AIR, Dist.CBD, Dist.ST, and Dist.BNTHWY, are significant. The coefficients of these variables are represented in the order of -1.182, -4.894, -0.386, and 0.607 with the t-statistics of -5.533, -10.946, -9.586, and 4.433. Since the t-statistics indicate the significance of all four variables, the null hypothesis can be rejected. Therefore, the slopes of all four dependent variables are not equal to zero, which means the average commercial land value is sensitive to all four independent variables. In this time period, the distance to the Bangkok CBD is still the most influential factor to affect the commercial land value by decreasing the price of commercial land by 489.4 percent as the distance to the Bangkok CBD increased by 1 percent. Also, the accessibility to transportation networks impacts land values as well. Especially for the airport, the coefficient indicates the negative impact on the commercial land value. This implies that the price of commercial land value decreased by 118.2 percent as the distance to the airport increased by 1 percent.

In addition, the attractiveness of the locations close to transportation networks also has an impact on the commercial land value, while the street network provides a negative impact on the land values. Therefore, as a commercial land use location shifts away by 1 percent from the nearest major street, the price of the commercial land decreases by 38.60 percent. However, the positive significance of the distance to Bang Na-Trad highway for this time period is quite different from the previous year, which has a negative impact on commercial land value. Therefore, the positive significance of the

Dist.BNTHWAY implies that the average commercial land value increased by 60.70 percent as the distance to the nearest point of the highway increased by 1 percent. As a result, since the market was reacting to the announcement of the new airport site, the change in the sign of the coefficient may reflect the presence of the new airport site.

During the period of airport construction in 2002, the result of stepwise regression analysis indicates that four of eight independent variables, which include Dist.CBD, Dist.ST, Dist.BNTHWY, and Dist.REC, are significant. Three signs of the coefficients, which are Dist.AIR, Dist.ST, and Dist.BNTHWY, match what was intuitively expected by the dissertation and also match those in previous studies specified by other authors (Alonso, 1964; Ratcliff 1971; Crowley, 1973; Weisbrod, Reed, and Neuwirth, 1993; Golaszewski, 2004; Kasarda and Applod, 2006). On the other hand, the Dist.REC variable was significant but it shows the opposite signs of coefficient from dissertation hypotheses. Moreover, the orders of coefficient of these variables, which are Dist.CBD (-1.208), Dist.ST (-0.307), Dist.BNTHWY (-0.231), and Dist.REC (0.070), from high to low impact the commercial land value., The results of the stepwise regression analysis affirm that the average commercial land value is most sensitive to the distance to the Bangkok CBD, while accessibility is still the second important factor affecting the price of commercial land. A negative sign on the coefficient for Dist.CBD would imply that the price of commercial land decreased by 120.80 percent as the distance to the Bangkok CBD increased by 1 percent. Similar to the Dist.ST and Dist.BNTHWY, the results of the negative sign on both coefficients would imply that the price of commercial land would decrease by 30.7 percent and 23.1 percent as the distance from the nearest major street and the nearest Bang Na-Trad highway both increase by 1 percent. Meanwhile, the

positive sign on the coefficient for Dist.REC indicates the increasing price of commercial land as the distance from the closest amenities increases. In this case, the change in land value slightly increases by 7 percent compared to other factors.

In the period after the opening of the airport in 2009, the result of stepwise regression indicates that six independent variables in the equation, which include Dist.AIR, Dist.CBD, Dist.ST, Dist.BNTHWY, Dist.BCACC, and Dist.BEACC, are significant. Five independent variables except the Dist.BCACC are all negatively significant with the coefficients of -0.529, -2.350, -0.309, -0.134, and 0.086, while the Dist.BCACC is positively significant with the unexpected result of 0.194. In this time period, the distance to the Bangkok CBD shows the highest impact on the commercial land value, while the accessibility to transportation facilities and networks is a less important factor affecting the price of commercial land. As a result, this would imply that the price of commercial land decreased by 235 percent as the distance to the Bangkok CBD increased by 1 percent.

Moreover, the price of commercial land in this period is also sensitive to the airport. As the distance to the airport increased by 1 percent, the price of commercial land decreased by 52.29 percent. In terms of accessibility to transportation networks, the average commercial land value decreased by 30.90 percent as distance to nearest major street increased by 1 percent and decreased by 13.40 percent as the distance to the nearest Bang Na-Trad highway increased by 1 percent. The value also decreased by 8.60 percent as the distance to the nearest access of Bangkok Eastern Outer Ring highway increased by 1 percent. On the other hand, since the sign of the coefficient of Dist.BCACC is positive, which is opposite from the expectation of the dissertation hypothesis, this

finding would imply that the price of commercial land slightly increases by about 8.6 percent as the distance to the nearest access of New Bangkok-Chonburi Highway increases by 1 percent. Because of the limited access to the highway and the convenience to access the business location, this result may affect the price of commercial land and the change in the sign on the coefficient of this variable.

Manufacturing and Warehouse Land

**Bid-rent model (simple regression analysis).**

The next model of bid-rent uses the natural log of average manufacturing and warehouse land value for 1995, 2002, and 2009 as the dependent variables. The natural log of Dist.AIR variable for each year enters into the equation. The results of the bid-rent analysis for manufacturing and warehouse are shown in table VI.1. All three models of the bid-rent analysis are significant. When the airport was proposed, the F-value of the model is 30.828. The F-value of the model for 2002, while the airport was under construction, is 51.174. The last model also indicates the significance of the model with F-value of 48.747. All significant F-values of the three models suggest that all of the parameter estimates are not equal to zero, which means there is sufficient evidence to determine that the independent variable, the natural log of Dist.AIR, fits into the regression model.

Furthermore, the results of the regression coefficients for the model of 1995, 2002 and 2009 are 0.482, 0.431, and 0.394, with t-value of 5.552, 7.154, and 6.982 respectively. The positive regression coefficients of the natural log of Dist.AIR explain the positive relationship between the natural log of Dist.AIR and the natural log of the average land value of manufacturing and warehouse for all three time periods. That

means the average land value of manufacturing and warehouse will increase when the distance to the airport is farther. Also, the positive signs of the coefficients for all three models are different from the hypothesis, which may be affected by variables other than the airport. The slope of the bid-rent curve for three models may be less steep over the three time periods because of the impact of the decentralization and the Sixth Five-Year National Economic and Social Development Plan (1987-1991. This Plan promotes the eastern seaboard development by providing some land for manufacturing and warehouse in the area around the airport, such as Inland Container Depot (ICD) in Lad Krabang district, for unloading the imported goods and loading exported goods or any class of such goods. That will have impact on the increasing of manufacturing and warehouse land values around the airport through the periods of study. Then its effect has changed the slope of the bid-rent curve to become less steep for 2002 and 2009.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.2, the results of the stepwise multivariate regression analysis of the four periods of time (1987, 1995, 2002, and 2009) for average manufacturing and warehouse land value indicate the significance of the models at the 5 percent level with the F-statistic of 113.299, 164.581, 310.753, and 29.290. Considering the adjusted R-squared, the results of adjusted R-square of four periods of time are 0.434, 0.539, 0.607, and 0.185. Since the F-statistics are significant for four periods of time, it is possible to reject the null hypothesis. Therefore, the results confirm that all parameter estimates in the four models are not equal to zero. These results indicate that the set of the independent variables of each year significantly represents the factors affecting manufacturing and warehouse land value in the northwest quadrant.

Considering the results of the stepwise regression analysis in the time prior to the airport, two of six explanatory variables are significant, which include Dist.CBD and Dist.ST variables. The coefficients of two independent variables are -1.893 and -0.300 with the t-statistic of-11.522 and -9.063. The results suggest that the distance to the Bangkok CBD is the most influential factor affecting the change in the value of manufacturing and warehouse land with the decreasing of the price by 115.22 percent as the distance to the Bangkok CBD is increased by 1 percent. Moreover, the location of the manufacturing and warehouse land, which is located close to the major street, will decrease the price of land by about 30 percent as the distance to the nearest major street is increased by 1 percent.

The 1995 equation suggests that four significant variables are contained in the equation, including Dist.AIR, Dist.CBD, Dist.ST, and Dist.BNTHWY with the coefficient of -0.879, -3.555, -0.413, and 0.452. The interpretation of the results indicates that the access to the CBD is still the most sensitive factor to influence the price of manufacturing and warehouse land with the decreasing of the price of land by 355.5 percent as the distance to the Bangkok CBD is increased by 1 percent. Moreover, accessibility to the transportation facility, the airport, helps increase the price of manufacturing and warehouse land. That means the price of land decreases by 87.9 percent as the distance to the airport site increases by 1 percent. This assumes that, after the airport site was proposed, the market of manufacturing and warehouse was reacting to the presence of the new airport and was valuing the increased accessibility in such a way that a location close to the new airport was worth more than a location farther away. In

terms of accessibility to transportation networks, one (Dist.ST) has a negative impact on the price of land, while another (Dist.BNTHWY) has a positive impact on the price of land. This would imply that access to the main street helps decrease the value of manufacturing and warehouse land by 41.3 percent as the distance to the main street increases by 1 percent. On the other hand, the major highway, Bang-Na Trad, helps increase the price of the land by 45.2 percent as the distance to the highway increases by 1 percent. This result was opposite to the expectation of the study although the variable is significant.

Considering the result of the 2002 equation, the result of the final step of the stepwise regression analysis indicates that three significant variables, which are Dist.CBD, Dist.ST, and Dist.BCACC, are included in the equation. The coefficients of these two variables are -1.023, -0.438, and 0.148. During the period of the airport construction, the price of manufacturing and warehouse land was highly sensitive to the accessibility to the Bangkok CBD, which decreased by 102.30 percent as the distance to the CBD increased by 1 percent. Access to the main street is the second important variable to help increase the value of land. That means the price of manufacturing and warehouse land decreased by 43.8 percent as the distance to the nearest main street increased by 1 percent. Unexpectedly, the Dist.BCACC variable provides the opposite impact on the value of land, which means the price of the land will increase by about 14.8 percent as the distance to the nearest access of the new Bangkok-Chonburi Highway increases by 1 percent. One noticeable fact is that access to the airport was not significant in the pricing of the land during the construction period. That may be because it is

unclear if it was government policy to provide land and infrastructure to support manufacturing and other facilities to relocate their facilities to the airport area.

The results of the 2009 equation indicate that five significant variables are obtained onto the final step of the stepwise regression model. The five significant variables with their coefficients are Dist.AIR (-0.378), Dist.CBD (-2.042), Dist.SMP (0.732), Dist.ST (-0.102), and Dist.BCACC (0.248). The results indicate that both the CBD of Bangkok City and Samut Prakarn province are significant. However, the accessibility to the Bangkok CBD is the most important factor to reflect the price of land. This variable decreases the price of land by 204.2 percent as the distance to the airport increases by 1 percent, while the Samut Prakarn CBD reflects the price of land by increasing the value by 73.20 percent as the distance moves farther away by 1 percent. In the period after the opening of the airport, the average price of manufacturing and warehouse land reflects prices close to the airport increasing by about 37.8 percent as the distance decreased by 1 percent. In addition, accessibility to transportation networks still reflects the price of manufacturing and warehouse land. The results indicate that Dist.BCACC provides positive impact of about 24 percent change on the value of land, while the distance to the nearest main street provides negative impact with a slight change of about 10 percent in land value during this period.

Vacant Land

**Bid-rent model (simple regression analysis).**

The empirical results of the bid-rent model for vacant land are shown in table VI.1. There are 3 simple regression equations for 1995, 2002, and 2009. The results of the three equations indicate that the models are significant with the F-value of 106.396,

58.870, and 45.821 respectively. Since the values of the F-statistic are significant for the three models, the results suggest that all parameter estimates are nonzero, which means there is sufficient evidence to indicate that the independent variable, which is the natural log of Dist.AIR, fits into the regression model.

In addition, the results of the regression coefficient of the natural log of Dist.AIR for the three equations are all positively significant related to the natural log of the average vacant land value with the highest coefficient for 1995 (0.727), lower for 2002 (0.435), and the lowest for 2009 (0.427). The t-tests of these three variables, which are 10.315, 7.673, and 6.769 in order, are significant at the 5 percent level. That means all slopes of the three independent variables in these three models are not equal to zero.

The results indicate that all the positive coefficients of the natural log of Dist.AIR represent a positive relationship between the distance to the airport and the average vacant land value for each year. In other words, when the distance to the airport increases, it will affect the average value of vacant land in proportion to the coefficient of the independent variable for each year.

**Hedonic pricing model (multivariate regression analysis).**

The results of stepwise multivariate regression analysis of average vacant land value for the four periods of time (1987, 1995, 2002, and 2009) are shown in table VI.2. The results of the stepwise regression models indicate the significance of the model at the 5 percent level with the F-statistic of 280.237 (1987), 227.003 (1995), 207.149 (2002), and 170.269 (2009). The adjusted R-squares of four periods of time are 0.438 (1987), 0.489 (1995), 0.437 (2002), and 0.429 (2009), which means the average vacant land

value is about 44 percent for 1987, 49 percent for 1995, 44 percent for 2002, and 43 percent for 2009, by all significant independent variables in the equation for each year.

The result of the stepwise regression analysis for the 1987 equation indicates that three independent variables are significant, with the t-statistic of Dist.CBD (-1.822), Dist.SMP (-0.451), and Dist.ST (-0.372). The result suggests that, during the time period prior to the airport, the price of vacant land for the northwest quadrant is highly sensitive to the Bangkok CBD and Samut Prakarn CBD. Since both variables have negative signs on the coefficient, these could imply that the price of vacant land decreased by 182.2 percent and 45.1 percent as the distance from the Bangkok CBD and Samut Prakarn CBD increased by 1 percent. Furthermore, the accessibility to a main street is still an important factor affecting the price of vacant land by decreasing 37.2 percent as the distance to the nearest main street increases by 1 percent. The findings of this period confirm that accessibility to the CBDs is the most influential factor and reflects the higher price of land closer to the CBDs. Moreover, the accessibility to transportation networks affects the price of land as well.

In the 1995 equation, the stepwise regression analysis reveals the result of five significant variables, which are Dist.AIR, Dist.CBD, Dist.SMP, Dist.ST, and Dist.REC, included in the equation. The coefficients of these variables are Dist.AIR (-0.540), Dist.CBD (-3.628), Dist.SMP (0.864), Dist.ST (-0.377), and Dist.REC (-0.173). The results suggest that the price of vacant land is sensitive to the accessibility to CBD, especially highly sensitive for the Bangkok CBD rather than Samut Prakarn CBD. The accessibility to the Bangkok CBD reflects the higher price of land as the distance moves closer to the CBD by about 362.80 percent, and a decrease in the price of land when the

distance is farther away by 1 percent. On the other hand, the Samut Prakarn CBD has a positive impact on the price of land, which is the opposite of the expectation. The result of the positive impact suggests that the price of land decreased by 86.4 percent as the distance to the Samut Prakarn CBD increased by 1 percent. Furthermore, the accessibility to the new airport during this period becomes significant with the negative sign of the coefficient. This would imply that the price of vacant land decreased by 54 percent as the distance increased by 1 percent.

Similar to the accessibility to transportation networks, Dist.ST, the result indicates that the price of vacant land would decrease as the distance to the nearest main street increased. Furthermore, the accessibility to amenities, Dist.REC, slightly impacts the change of the land value. The price of land decreases only by 17.3 percent as the distance to the nearest recreation increases by 1 percent. The conclusion of the finding for the period after the new airport site was proposed indicates that the access to the CBDs is still an important factor affecting the price of land. Also, access to the new airport site and main streets becomes a significant factor and is reflected in the price of available land around the airport.

With the 2002 equation, which is the time period during the airport construction, the result of stepwise regression indicates that four variables are significant and contained in the equation. These four variables and their coefficients are Dist.AIR (-0.171), Dist.CBD (-1.656), Dist.ST (-0.340), and Dist.BCACC (0.221). The result indicates that the distance to the Bangkok CBD is still the most important factor to affect the price of vacant land in this period, with the price decreasing by 165.6 percent as the distance to the Bangkok CBD increases by 1 percent. Second, accessibility to the transportation

network and facility reflects higher prices closer to main streets and the airport location. While accessibility to new Bangkok-Chonburi highway is positively significant in this period, this would imply that the price of vacant land increased by 22.10 percent as the distance to the access of the new Bangkok-Chonburi highway increased by 1 percent.

Considering the 2009 equation, the result indicates that four variables, which include Dist.CBD, Dist.ST, Dist.REC, and Dist.BCACC, are significant. The coefficients of four variables are Dist.CBD (-1.334), Dist.ST (-0.345), Dist.REC (-0.126), and Dist.BCACC (0.107). The model demonstrates the effect of the Bangkok CBD on the price of vacant land, with the price decreasing by 133.4 percent as the distance moves farther away by 1 percent. The finding also suggests that the price of vacant land increases as the location of vacant land moves closer to main streets. Similar to the Dist.REC, the result suggests that the prices of vacant land would reflect higher prices closer to the recreational areas. However, the model determines a positive impact on the distance to the nearest access to the new Bangkok-Chonburi highway. The value of vacant land changes slightly, increasing 10 percent as the distance to the nearest access increases by 1 percent. Another noticeable finding is that the accessibility to the airport is not significant during this time.

Summary of Findings of the Northwest Quadrant

Five conclusions can be drawn from the statistical analysis results of this quadrant. First, in the bid-rent model, the proximity of the properties for all six types of land use to the airport has positive impact on the prices of land through the three time periods (1995, 2002, and 2009), except for agriculture land values for 2002 and 2009, which do not have impacts from the airport. Since the study area of the northwest

quadrant is close to the Bangkok CBD, the impact of the exogenous factors from the Bangkok CBD may play an important role to affect the prices of land rather than the proximity to the airport.

Second, The statistical results of the bid-rent model indicate the positive impact of the proximity to the airport on land values. These results may be related to the high density in the core area and the impact of the Bang Kapi-Hua Mak sub-center, which has high density from various kinds of developments and land use activities, rather than to the airport area. According to the land use comprehensive plans of Bangkok for 1999 and 2006 (Appendix A and B), the area at the Bang Kapi market was defined in 1999 as a commercial land use (red) and surrounding by the medium-density residential land use (brown). In 2006, the Department of City Planning, Bangkok Metropolitan Administrator extended the commercial land use zone and medium-density residential area along Ramkamheang Road to support the rapid growth of the area, while these two zonings were surrounded by the low density residential land use zone (yellow).

In the past 40 years, the area of Bang Kapi- Ramkamheang has been in a transition period of rapid urbanization, with the expansion of the city occurring along the major street arteries. The period of transition occurred in the 1970s after the establishment of the National Institute of Development Administration in 1966, Ramkamheang University in 1971, and Assumption University in 1990. Ramkanheang and Assumption Universities are both located on Ramkamheang Road and attracted new commercial and residential activities to the area. The National Institute of Development Administration is located on Seri Thai Road.In term of commercial activities, low-order businesses, such as groceries, supermarkets, restaurants, and copy centers, tended to

cluster around the universities and along Ramkamheng road. At the same time, the high-order retail businesses, such as large scale shopping malls, car dealerships and businesses offices, tended to cluster along commercial corridors such as Ramkamheang and Srinagarindra Road. The National Institute of Development Administration had a similar impact on increasing new developments of low and high-order of retail businesses along Seri Thai Road, Lat Phrao Road, and the Bang Kapi market. In fact, with the increasing commercial developments in the area, employment in the service sector increased dramatically in the last four decades because of the migration of labor from other areas and the shift of employment in the area from the agriculture sector to the service sector.

To support the growth and the increasing population, new developments of residential units, surrounded by the development of commercial activities, increased rapidly over the past 40 years. Mostly in the first phase of the residential development, low-income residential units, such as the Klong Chan project and Seri Village, were provided by the public and private sectors. These developments consist of multi-family housing units and single housing units. Furthermore, high-density residential units, such as apartments, dormitories, and condominiums, have been developed intensively along Ramkamheang Road and the Bang-Kapi market, around the three universities, and some other areas where the accessibility to the development site is importance.

As a result of the rapid growth of this area, it can be concluded that developments along the Ramkamheang Road and Bang Kapi market became more intensive and competitive than other areas in the northwest quadrant. The land along the Ramkamheang commercial corridor had been donated for high- and low-order retail businesses because of the agglomeration economies and high accessibility to street fronts,

while the high and low-density residents tended to cluster around the commercial activities. In addition, the three universities located in the Ramkamheang area caused an increase of high-density residential development in the area to provide living accommodations for students and staff.

The increasing density in the area of Ramkamheng University and the Bang Kapi market is reflected in the higher land values through the three periods of time compared to the area around the airport, which had lower density and competition. After the announcement of the new site in 1995, developers began speculating on the land around the airport for future development. However, still many problems exist concerning the restrictions of airport land use regulations, which do not allow the developers to construct any buildings that exceed the limitation of the density of Floor Area Ratio (FAR). Therefore, these limitations have limited the density of the area around the airport, which resulted in the prices of land increasing less than the area of Ramkamheang and the Bang Kapi market. Also, the Asian Financial Crisis of 1997 slowed down the new development in all areas, including the area around the airport. As a result, the statistical results of the bid-rent model indicated the positive impact of the proximity to the airport on the urban land values for the northwest quadrant.

Third, the results of the stepwise multivariate analysis affirm the consistently negative significance of access to the Bangkok CBD throughout the four time periods for every land use types. Prices decrease for lands farther away from the CBD. The results confirm the high concentration of various types of development in the Bangkok CBD and the advantage of the agglomeration of economies. The prices of land in the Bangkok CBD are most sensitive to access to the CBD rather than any other factors.

Fourth, the analysis of the results also confirms the impact of the direct access to main streets on the prices of land. Because of the advantage of locations attached to main streets, residential land will benefit from high-accessibility sites to transportation networks for work and for other trips. Furthermore, the more accessible land has a greater capacity to support profitable business activity. Therefore, businesses wishing to maximize profits will compete for these accessible locations. As a result, the prices of land attached to the streets will have higher prices than land father away from the streets.

Finally, the stepwise regression results in the negative impact of the airport site on the land values, especially in 1995. When the first reports of the new airport site were released in 1991 with a detailed description of the location, the market for land around the airport reacted to the announcement. Moreover, the negative significance in 2009 of the distance to the airport for high-density residential, commercial, and manufacturing and warehouse land supports the just-in-time production concept by Kasarda (1999). This concept indicates that manufacturer will customize production to offer speed and flexibility in the delivery process from the time their assembled product leaves the factory until the time they arrive on the customer's doorstep. That means firms find warehousing close to the airport in order to improve overall performance.

Also, since the advent of the aerotropolis concept, the passenger terminal can be determined as the core function, while the clustering of the businesses occurs around the airport to generate the agglomeration economies. This would cause the prices of land in 2009 to reflect higher prices closer to the airport for commercial and for manufacturing and warehouse land. In terms of high-density residential land, the only explanation of the significance of this variable concerns the increase in the number of jobs associated with

the airport businesses and airline operations. With the presence of the location near the airport and high accessibility to the airport, these jobs would be the first choice for people who choose to live close to their workplace. On the other hand, the insignificance of the low-density residential land in 2009 is due to the effect of noise pollution on the location closer to the airport area, which reduces the price of land. In addition, it is the result of the intervention in property land values in 2006 by the National Housing Authority, which assisted in arranging a real estate project, included single housing unit and townhomes for 17,000 employees to purchase at special prices in the area closer to the airport (Bangkokairportonline.com).

**Northeast Quadrant**

The second study area is the northeast quadrant, which covers the two jurisdictions of Bangkok City and Samut Prakarn Province. The study area of Bangkok City includes three districts: Lat Krabang, Nong Jok, and Min Buri. The study area in Samut Prakarn Province includes two districts: Srisa Chorakhe Noi and Bang Sao Thong. The discussions will focus on the results of the two models of bid-rent and stepwise multivariate regression analysis throughout the four time periods.

**Table VI.3: Log Linear Regression for Parameters of Bid-Rent Function, Northeast Quardrant**

| Land Use | 1995 | | | 2002 | | | 2009 | | |
|---|---|---|---|---|---|---|---|---|---|
| | b | t | F | b | t | F | b | t | F |
| **Agriculture** | -1.421 | -15.982 | 255.415 | -1.014 | -10.884 | 118.468 | -1.312 | -12.772 | 163.127 |
| **Low-Density Residential** | -0.656 | -7.203 | 51.880 | -0.601 | -4.880 | 23.817 | -0.886 | -8.202 | 67.275 |
| **High-Density Residential** | -2.876 | -7.012 | 49.170 | -0.631 | -3.063 | 9.382 | -0.602 | -4.501 | 20.260 |
| **Commercial** | -3.154 | -11.627 | 135.188 | -1.035 | -8.852 | 8.359 | -0.958 | -7.741 | 56.859 |
| **Manufacturing & Warehouse** | -1.123 | -4.574 | 20.923 | -0.552 | -2.752 | 7.576 | -0.341 | -2.450 | 6.004 |
| **Vacant Land** | -1.609 | -12.431 | 154.521 | -1.390 | -10.878 | 118.321 | -1.047 | -7.933 | 62.934 |

$\alpha$ = 5 percent level

Dependent variable is LN(Land Value)

Independent variable is LN(Distance to Airport)

**Table VI.4: Results of Stepwise Log Linear Multiple-Regression on Land Value by Land Use Type and Year, Northeast Quadrant**

| Land Use / Variable | Agriculture | | | | L-Density Residetial | | | | H-Density Residential | | | | Commercial | | | | Manufacturing & Warehouse | | | | Vacant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 |
| 1. Dist.AIR | | -1.243 | 0.325 | -0.870 | | | | | | -2.876 | -1.975 | -0.693 | | -3.642 | -2.210 | -1.280 | | -1.256 | | | | -1.099 | -1.043 | |
| | | (-16.268) | (1.532) | (-8.634) | | | | | | (-7.012) | (-7.175) | (-5.407) | | (-10.439) | (-13.333) | (-9.147) | | (-5.605) | | | | (-9.816) | (-9.665) | |
| 2. Dist.CBD | | | -2.221 | | | -1.395 | -2.741 | -3.512 | - | | 4.587 | | | 3.663 | 2.348 | | | | -3.018 | -1.160 | | | | -2.352 |
| | | | (-5.650) | | | (-3.309) | (-6.934) | (-11.026) | | | (3.815) | | | (2.464) | (4.480) | | | | (-5.027) | (-3.096) | | | | (-7.567) |
| 3.Dist.MMBP | | | | | | | | | - | | | | -9.619 | | | | | | | | | | | |
| | | | | | | | | | | | | | (-12.018) | | | | | | | | | | | |
| 4. Dist.CCS | | | | | | | | | - | | | | | | | | | | | | 1.758 | 0.924 | | |
| | | | | | | | | | | | | | | | | | | | | | (3.042) | (2.770) | | |
| 5. Dist.ST | -0.504 | -0.374 | -0.264 | -0.342 | -0.453 | -0.321 | -0.297 | -0.308 | - | | -0.348 | -0.209 | -0.401 | -0.392 | -0.156 | -0.222 | -0.474 | -0.282 | -0.271 | -0.260 | -0.500 | -0.391 | -0.262 | -0.318 |
| | (-24.625) | (-19.682) | (-12.547) | (-15.952) | (-11.928) | (-11.419) | (-8.943) | (-10.818) | | | (-5.905) | (-3.260) | (-3.304) | (-3.483) | (-3.463) | (-3.669) | (-7.995) | (-4.410) | (-5.149) | (-6.748) | (-15.804) | (-17.143) | (-10.222) | (-12.727) |
| 6. Dist.BNTHWY | | | -1.729 | | | -2.383 | | -0.685 | - | | | | | | | | -2.427 | | | | -1.842 | | | -1.765 |
| | | | (-4.764) | | | (-12.225) | | (-3.532) | | | | | | | | | (-4.001) | | | | (-4.338) | | | (-5.014) |
| 7. Dist.REC | -0.364 | -0.128 | | | -0.709 | -0.384 | -0.171 | | - | | | | | -0.313 | | | -0.486 | | | | -0.432 | -0.185 | -0.301 | |
| | (-7.202) | (-2.653) | | | (-13.124) | (-8.169) | (-3.274) | | | | | | | (-2.691) | | | (8.209) | | | | (-4.350) | (-3.756) | (-6.283) | |
| 8. Att.CANAL | | | | 0.189 | | | | | | | | | | | | | | | | | | | | |
| | | | | (3.319) | | | | | | | | | | | | | | | | | | | | |
| 9. Dist.BCACC | | | | -0.106 | | | | | | | 0.505 | | | | 0.697 | 0.230 | | | | | | | | 0.129 |
| | | | | (-2.123) | | | | | | | (3.866) | | | | (8.015) | (3.225) | | | | | | | | (1.990) |
| 10. Dist.BEACC | | | | | | | | | | | | | | | | | | | | | | | | |
| 11. Dist.ALS | | | | | | | | | | | | | | | | | | | | | | | | |
| Constant | 5.433 | 8.032 | 19.088 | 9.298 | 6.245 | 17.064 | 17.404 | 21.781 | - | 13.030 | -3.317 | 10.268 | 34.391 | 1.389 | 5.019 | 11.278 | 12.687 | 8.590 | 18.452 | 12.237 | 4.603 | 4.534 | 10.272 | 20.392 |
| F-Statistic | 349.783 | 293.811 | 88.087 | 135.282 | 201.695 | 98.802 | 57.181 | 93.063 | - | 49.170 | 19.998 | 16.898 | 73.937 | 51.531 | 57.194 | 30.108 | 77.711 | 22.512 | 26.029 | 24.759 | 129.804 | 158.142 | 107.502 | 69.093 |
| Ajusted $R^2$ | 0.530 | 0.658 | 0.444 | 0.566 | 0.661 | 0.599 | 0.367 | 0.434 | - | 0.658 | 0.628 | 0.319 | 0.844 | 0.771 | 0.742 | 0.452 | 0.822 | 0.339 | 0.315 | 0.207 | 0.651 | 0.683 | 0.554 | 0.499 |
| Sample Size | 619 | 458 | 438 | 413 | 207 | 263 | 292 | 361 | - | 26 | 46 | 69 | 28 | 61 | 79 | 107 | 51 | 85 | 110 | 183 | 277 | 293 | 258 | 274 |

Note: Significant at 5 percent level

Variables: 1. Distance to Airport (Dist.AIR), 2. Distance to Bangkok CBD (Dist.CBD), 3. Distance to Mueng Mai Bang Phli (Dist.MMBP), 4. Distance to Cha Cheng Sao (Dist.CCS)
5. Distance to Nearest Major Street, 6. Distance to Bang Na-Trad Highway (Dist.BNTHWY), 7. Distance to Recreation (Dist.REC), 8. Attach to Canal (ATT.CANAL)
9. Distance to Bangkok-Chonburi New Highway Access (Dist.BCACC), 10. Distance to Bangkok Eastern Outer Ring Highway Access (Dist.BEACC), 11 Distance to Airport Link Station (Dist.ALS)

Model: * 1987, Variables include Variable 2-8 * 1995, Variables include Variable 1-8 * 2002, Variables include Variable 1-10 * 2009, Variables include Variable 1-11

Agriculture Land

**Bid-rent model (simple regression analysis).**

According to table VI.3, the results of the F-statistic tests for the bid-rent model in 1995, 2002, and 2009 indicate that all three models of agricultural land bid-rent curve are significant. The result of the F-statistic test of 1995 is 255.415, 2002 is 118.468, and 2009 is 163.127. These three F- statistic tests are significant at the 5 percent level, which means there is sufficient evidence to determine that the independent variable, the natural log of Dist.AIR, fits into the regression model in order to respond to the change in average agriculture land values in the northeast quadrant for all three years.

Moreover, the results of the coefficient regression for the three years are shown in table 6.3. The empirical results of the regression coefficient of the natural log of Dist.AIR for all three models are negatively significant relative to the natural log of average agricultural land values. For 1995, 2002, and 2009, the coefficients of the natural log of Dist.AIR are -1.421, -1.014, and -1.312, while the t-statistics are -15.982, -10.884, and -12.772. The significance of t-statistics indicates that the slopes of all three models are not equal to zero. That means the average agricultural land values are sensitive to the distance to the airport, while the average agricultural land values in 1995 rather than in 2002 and 2009 are more sensitive to the distance to airport. The slope of the bid-rent curve for 1995 is the steepest and then lessens in 2002. However, in 2009 the slope of the bid-rent curve jumped again after the airport opened. Another consideration concerns the sign of the coefficients of all three models. While all of the coefficients have negative signs, these results support the hypothesis of the model, by which the land value should decrease when the distance to the airport increases.

As a result of the unstable decrease in the slope of bid-rent curve over these time periods, the average agriculture land value may have an impact not only from the distance to the airport, but also from other factors that may cause the change in the slope for later years.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.4, the results of the stepwise multivariate regression analysis of the four time periods (1987, 1995, 2002, and 2009) for average agricultural land values indicate the significance of the models at the 5 percent level with the F-statistics of 349.783, 293.111, 88.087, and 135.282. Considering the adjusted R-squared, the results of the adjusted R-square of the four periods of time are 0.530, 0.658, 0.444, and 0.566. Since the F-statistics are significant for the four periods of time, it is possible to reject the null hypothesis. Therefore, the results confirm that all parameters estimated in the four models are not equal to zero. These results indicate that the set of independent variables for each year significantly represent the factors affecting agricultural land values in the northeast quadrant.

Analyzing the results of the 1987 equation, the result of stepwise regression indicates that two independent variables, which are Dist.ST, and Dist.REC, are significant in this time period. The coefficients of two variables are in the orders of -0.504 and -0.346 respectively. The negative sign on both variables indicates the percent change of the price of land will decrease as the distance to the accessibility and amenity increases by 1 percent. In this period, the average agricultural land value is more sensitive to the distance to the nearest main street than the distance to the closest recreational area. As a result, this would imply that the price of the land would decrease

by 50.4 percent as the distance to the nearest main street increases by 1 percent. This compares to the price of land decreasing by 34.6 percent as the distance of the closest recreational area increases by 1 percent. The analysis indicates that the three CBDs of Bangkok City, Muang Mai Bang Phli District, and Cha Cheng Sao Province have significant impact on agricultural land values.

In the 1995 equation, the result of stepwise regression reveals three significant variables, which are Dist.AIR, Dist.ST, and Dist.REC, in the equation. The three coefficients of these variables indicate the negative impact on the value of land with the coefficients of Dist.AIR (-1.243), Dist.ST (-0.374), and Dist.REC (-0.128). The interpretation of these three would imply that the future airport, direct access to main streets, and recreational areas help increase the price of the agricultural land. Moreover, the prices of agricultural land in this time period are more highly sensitive to the future airport site than to direct access to main streets and recreational areas. However, direct access to main streets seems to be more influential on the price of land than recreation. In this case, the price of land would decrease by 124.3 percent as the distance to the future airport site increases by 1 percent, by 37.4 percent as the distance increases from the main street by 1 percent, and by 12.8 percent as the distance to the closest recreation area increases by1 percent. Similar to the 1987 model, the outcome of the analysis indicates the insignificance of the CBDs during this period of time.

During the airport construction (2002), the result of the stepwise regression model indicates that four significant independent variables were entered into the equation. The four significant variables with coefficients shown in order from the most to the least important include Dist.CBD (-2.221), Dist.BNTHWY (-1.729), Dist.AIR (0.325), and

Dist.ST (-0.264). The accessibility to the CBD as well as the accessibility to transportation networks and facilities are significant in this period. As a result, these findings imply that the value of agricultural land in this year reflects higher prices, which increase by about 222.1 percent for every 1 percent closer to the airport, while the price of land decreases by 172.9 percent and 26.4 percent as the distance to the nearest Bang Na-Trad Highway and distance to direct access of main street increases by 1 percent. In terms of Dist.AIR, although the Dist.AIR variable at this time is significant, the result of the coefficient indicates the positive impact on agricultural land value, which is opposite to the expectation of the dissertation. This would imply that the prices of agricultural land in 2002 increased by 32.5 percent as the distance to airport increased by one percent.

After the opening of the airport (2009), the result of the stepwise regression reveals that four significant variables, which include Dist.AIR, Dist.ST, Att.CANAL, and Dist.BCACC, are entered into the equation. The coefficients of the four variables are -0.870, -0.342, 0.189, -0.106 respectively. The negative sign of the three variables indicates the negative impact on the value of land for the three variables. The interpretation of the results suggests that the prices of agricultural land decreases the most by 87 percent as the distance to the airport increases by 1 percent. Secondly, the distance to nearest main streets affects the prices of land by decreasing about 34.2 percent as the distance increases by 1 percent, while the distance to the nearest access of the new Bangkok-Chonburi Highway reflects the price of land, which decreases slightly by 10.6 percent as the distance to the nearest highway access increases by 1 percent. For the agricultural land that adjoins the canal, the result is positively significant, which would

imply that the canal has impact on the price of land by increasing by about 18.9 percent as the distance to the canal increases by 1 percent.

Low-Density Residential Land

**Bid-rent model (simple regression analysis).**

In the bid-rent model, the outcome of the analysis of the variance (table VI.3) shows the result of the F-value, which indicates the bid-rent model of all three periods of time are significant for the average of low-density residential land values as related to the distance to the airport. The F-value of 1995, 2002, and 2009 are 51.88, 23.817, and 67.275 respectively. Since all the F-values are significant, there is sufficient evidence to indicate that the natural log of Dist.AIR fits into the regression model for all three periods of time.

According to table VI.3, the coefficient regression of the natural log of Dist.AIR for all three periods of time shows negatively significant results. The coefficients of the natural log of Dist.AIR are in the order of -0.658, -0.601, and -0.886, while the t-statistics are -7.203, -4.880, and -8.202 for 1995, 2002, and 2009. These t-statistics indicate the significance of the slope, which is not equal to zero at a significance of 5 percent level. Also, all three t-statistic tests suggest that the average low-density residential land value is sensitive to the distance to the airport, while the average low-density residential land value for 1995 is more sensitive to distance to the airport than in 2002. After the airport opened in 2009, the average low-density residential land values become most sensitive to the distance to the airport rather than in 1995 and 2002. As a result, the average low-density residential land values for three periods decrease when the distance to the airport increases, which is supported by Alonso's urban land use theory (1964). In terms of the

residential land value, the price of land will decrease with the distance from the center because of the advantage of cheaper land located farther away. By increasing the distance from the CBD, the householder can find more space for living to his/her satisfaction (Alonso, 1964).

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.4, the results of the stepwise regression analysis of the four periods of time indicate the significance of the models, with the F-statistics of 201.695 (1987), 98.802 (1995), 57.181 (2002), and 93.063 (2009). Also, the adjusted R-squares of the four models are 0.661 (1987), 0.599 (1995), 0.367 (2002), and 0.434 (2009). The results of the adjusted R-square suggest that about 66 percent of the average low-density residential land value can be explained by the independent variables entered in the equation for the year 1995, while 60 percent, 37 percent, and 43 percent of the average of price of low-density residential land can be explained by the independent variables in the equation for the years 1995, 2002, and 2009.

In addition, the result of the 1987 equation indicates that two of the independent variables are significant in the final step of the stepwise regression analysis. These two variables with the coefficients are Dist.ST (-0.453), and Dist.REC (-0.709). The result suggests that the distance closest to recreational areas has higher impact on the price of land than to the direct access to the main street. As a result, the price of land in these years decreases by 70.9 percent as the distance from the closest recreational area increases by 1 percent, while the price of land decreases by 45.3 percent as the distance to main street increases by 1 percent.

In the 1995 equation, the result of stepwise regression reveals that four independent variables, which include Dist.CBD, Dist.ST, Dist.BNTHWY, and Dist.REC, are significant. The coefficients of these variables are -1.395, -0.321, -2.383, and -0.384 respectively. The result of the coefficients indicates a negative sign for all four independent variables. That means the prices of the land during this year reflect higher prices closer to the Bangkok CBD, the direct access to main streets, the direct access to Bang Na-Trad Highway, and recreational areas. As a result, the prices of the low-density residential land in this year are the most sensitive to the distance to Bang Na –Trad Highway, while the distance to CBD, distance to recreational areas, and distance to the main street are more important respectively. .

During the period of construction, the result of the model indicates the significance of three independent variables. The three significant variables with the coefficients are Dist.CBD (-1.395), Dist.ST (-0.297), and Dist.REC (-0.171). Since the result provides a negative sign on all coefficients, this would imply that the prices of land during this period reflect higher prices closer to the Bangkok CBD, main streets, and recreational areas. As a result, the distance to the CBD, rather than other variables, seems to have a high impact on the value of land, while the prices of land decrease by 139.5 percent compared to 29.7 percent and 17.1 percent as the distance to CBD, the main street, and recreational areas increased by 1 percent.

The result of the final equation, 2009, indicates that three variables, which are Dist.CBD, Dist.ST, and Dist.BNTHWY, are significant in this period of time. The result of coefficients of three variables is -3.512, -0.308, and -0.685 respectively. The negative signs on all three coefficients suggest the negative impact of the Dist.CBD, Dist.ST, and

Dist.BNTHWY on the value of land. Also, the result of this period of time demonstrates that the CBD is still the most influential factor on the price of low-density residential land rather than main streets and the highway.

High-Density Residential Land

**Bid-rent model (simple regression analysis).**

The analysis of variance of the high-density residential land is shown in Appendix B. The results of the F- statistics for the three periods of time are 49.170 (1995), 9.382 (2002), and 20.260 (2009) with significance of p-value 0.000. Those results indicate that the parameter estimates for the three periods of time are not equal to zero. Therefore, there is sufficient evidence to determine that the natural log of Dist.AIR fits into the regression model for all three periods of time to explain the change in the average high-density land value.

In table VI.3, the results of the coefficient regression for all three period of time indicate that the coefficients of this variable for the three periods of time are statistically different from zero. While the coefficient of 1995 is -2.876, 2002 is -0.631, and 2009 is -0.602 with t-statistic of -7.012, -3.063, and -4.501, respectively. The results of the three t-statistics indicate the significance of the slopes, which are not equal to zero at significance of 5 percent level. These statistics could be interpreted to indicate that the distance to the airport affects high-density residential land value. Moreover, with the negative coefficients, these results explain the negative impact of the distance to the airport on the average high-density residential land value over the time period of the study. This means the average high-density residential land value will decline with the

increase of the distance from the airport. The finding is consistent with Alonso's study (1964) and Crowley's study (1973).

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.4, the results of the stepwise regression model for high-density residential land are available for only three periods of time --1995, 2002, and 2009. The result does not include the 1985 model because a large enough sample size was not available to run the stepwise regression analysis. Since data are available for the later time periods, the results of the stepwise regression indicate the significance of the model for all three periods of time with the F-statistic of 49.170 (1995), 19.998 (2002), and 16.898 (2009). The adjusted R-squares indicate a high relationship between dependent and independent variables for the first two periods with adjusted R-squares of 0.658 (1995), and 0.628 (2002), while the adjusted R-square of the 2009 is lower with 0.319. The result of the F-statistic is very low, which may be due to the small sample size of this type of land use in the northeast quadrant.

For the 1995 equation, the result of the stepwise regression of the period of time indicates that only one variable is significant, which is Dist.AIR with the coefficient of -2.876. The negative sign on the coefficient suggests that the prices of high-density residential land reflect higher prices closer to the site of the airport. This would imply that the average high-density residential land value decreased by 287.6 percent as the distance to the site of the airport increased by 1 percent. The result also confirms that the market for high-density residential land was reacting to the announcement of the new airport and also the increasing value of accessibility in such a way that a location closer to the airport was worth more than location farther away.

In 2002, the results for this year reveal the significance of the equation with four significant independent variables entered into the equation. These four variables and their coefficients are Dist.AIR (-1.975), Dist.CDB (4.587), Dist.ST (-0.348), and Dist.BCACC (0.505). The negative signs of the two independent variables, which are Dist.AIR, and Dist.ST, suggest that the value of land would reflect higher prices closer to the airport and with direct access to the main street. On the other hand, the unexpected positive signs on the coefficients of Dist.CBD and Dist.BCACC suggest the price of land increased as the distance to CBD and new Bangkok-Chonburi Highway access increased. Since these two variables are significant with the opposite sign from the expectation of the dissertation, the presence of the small sample size in this year may cause any possible conclusion.

Considering the period after the airport opening, the result of the stepwise regression model indicates that two significant variables are entered into the equation. These two variables are Dist.AIR, and Dist.ST with the coefficients of -0.693, and -0.209. These two variables show a negative sign on both coefficients, which means the price of land in this period of time, reflects higher prices closer to the airport and closer to direct access to the main street. This would imply that the price of land decreased by 69.3 percent as the distance to the airport increased by 1 percent, compared to the distance to the nearest main street as the price of land decreased by only 20.9 percent. One noticeable result is that the distance to the Bangkok CBD is not significant during this period of time because of the small sample size of high-density residential land and the distance to the Bangkok CBD is too far to have impact on land value for this quadrant.

Commercial Land

**Bid-rent model (simple regression analysis).**

The result of ANOVA (table VI.3) shows that the test of the model fits for all three periods of time by using the natural log of Dist.AIR as the only explanatory variable for each year. All models are significant with the F-value of 135.188 (1995), 8.359 (2002), and 56.859 (2009) with the significance at the 5 percent level. It is possible to reject the null hypothesis that the coefficient of the natural log of Dist.AIR variable is equal to zero for each time period of the study. That means the independent variable, the natural log of Dist.AIR, fits into the regression model.

The next stage in the analysis was to test whether the coefficient on the natural log of Dist.AIR changes over the period of the study. The results of the coefficient regressions are represented in table VI.3. The coefficient regressions of the natural log of Dist.AIR for all three periods of time show negatively significant results. The coefficients of the natural log of Dist.AIR are in the order of -3.154, -1.035, and -0.958, while the t-statistics are -11.672, -8.852, and -7.741 for 1995, 2002, and 2009. That means all slopes of the three independent variables within the three models are not equal to zero. The negative signs of all three coefficients indicate that the location rent of the commercial land will decline with the increase of the distance from the airport. This argument is consistent with earlier studies (Alonso, 1964; Crowley, 1973; Weisbrod, Reed, and Neuwirth, 1993; Golaszewski, 2004; Forsyth 2004).

Moreover, the comparison of the coefficients over the periods of time indicates that in 1995 the average commercial land value was more negative than in other years. These results confirm that firms and businesses were reacting to the presence of the

future airport since the airport was proposed in 1991 and were valuing the increased accessibility in such a way that a location closer to the airport was worth more than a location farther away.

**Hedonic pricing model (multivariate regression analysis).**

The results of the stepwise regression analysis of commercial land value for the four periods of time are shown in table VI.4. The results of testing the model for the four periods of time are significant with the F-statistics of 73.937, 51.531, 57.194, and 30.108, while the adjusted R-squares are 0.844, 0.771, 0.742, and 0.452. The results suggest that about 84% (1987), 77% (1995), 74% (2002), and 45% (2009) of the spatial variations of commercial land value are explained by the independent variables in each equation.

Considering the result of the stepwise regression equation for year 1987, the result indicates the significance of two variables entered into the equation with the significance of 5 percent level. The two significant variables with their coefficients are Dist.MMBP (-9.619), and Dist.ST (-0.401). The negative sign on these coefficients represents the negative impact of these variables on the commercial land value. As a result, the prices of commercial land reflect higher prices closer to the Muang Mai Bang Phli CBD. The Muang Mai Bang Phli project is a high-density residential area with an industrial park on site. Therefore, the market for commercial land at this time reacts to the upcoming project to reflect that the price of land will increase with the distance to Muang Mai Bang Phli CBD. Also, the prices of commercial land are sensitive to the direct access to the main street, which means the price of land would decrease as the distance from the main street increased.

After the airport site was proposed, the result of the 1995 equation reveals that four significant independents variables are entered into the equation. These four variables with coefficients are Dist.AIR (-3.642), Dist.CBD (3.663), Dist.ST (-0.392), and Dist.REC (-0.313). The result indicates that the Dist.CBD is significant with the positive sign on its coefficient, which is opposite to the expectation of the dissertation. However, this would imply that prices of commercial land increased by 366.3 percent as the distance to the Bangkok CBD increased by 1 percent. Unfortunately, the presence of the multicollinearity in this year precludes any possible conclusion from the result. Also, the small sample size of the commercial land at that time may affect the change of the sign. Furthermore, the result suggests that prices of commercial land in this year also reflect higher prices closer to the airport site. Similar to the distance to a major street, prices of commercial land are higher when the land is closer to main streets. Also, the price of land would increase as the distance to the closest recreational area decreases.

During the period of airport construction in 2002, the result of the stepwise regression equation indicates the significance of the four independent variables entered into the equation. The four variables and their coefficient are Dist.AIR (-2.210), Dist.CBD (2.348), Dist.ST (-0.156), and Dist.BCACC (0.697). Similarly to the 1995 model, the Dist.CBD is the most influential factor with a positive impact on the price of the land. In addition, the new independent variable that is entered into the equation is Dist.BCACC with the positive impact on the prices of commercial land. This positive impact of the Dist.BCACC suggests that the price of the land increased by 69.7 percent as the distance to the nearest access of the New Bangkok-Chonburi highway increased by 1 percent. Furthermore, the other two independent variables, which are Dist.AIR and

Dist.ST, still provide a negative impact on the value of land just as they did the previous time.

After the opening of the airport, the result of the model indicates the significance of three independent variables for this period. These three independent variable and the coefficients are Dist.AIR (-1.280), Dist.ST (-0.222), and Dist.BCACC (0.230). The result suggests that in this time period the distance to the airport has impact on the value of land by decreasing the prices about 128 percent as the distance to the airport increases by 1 percent. Similar to the Dist.ST variable, the result suggests that the prices of commercial land decreased by 22.2 percent as the distance to the direct access to a main street increased by 1 percent. On the other hand, since the new Bangkok-Chonburi highway has been used for a while, the result of the model still indicates the positive impact of the highway on the value of land. This would imply that the value of commercial land would reflect lower prices closer to the highway access.

Manufacturing and Warehouse Land

**Bid-rent model (simple regression analysis).**

Considering the analysis of variance (table VI.3), the results of the F-statistic of the non-linear simple regression models of 1995, 2002 and 2009 are 20.923, 7.576, and 6.004 with the natural log of Dist.AIR variable for each year entered into the equation. The results of the F-statistic of the three periods indicate that the F-statistics of all three periods of time are all significant at the 5 percent level. That means the log linear regression equation is significant, which means all parameter estimates of the three models are not equal to zero. Therefore, the independent variable, the natural log of Dist.AIR, fits into the regression model.

In addition, the results of the coefficient regression of the three models for 1994, 2002, and 2009 are -1.123, -0.552, and -0.341 with t-statistic of -4.574, -2.725, and -2.450 (table VI.3). The results indicate that all three parameter estimates are significant at the 5 percent level. That means the slope of the three variables is not equal to zero. Since the coefficient of the natural log of Dist.AIR has a negative impact on the value of land, the location rent of the manufacturing and warehouse land will decline with the increase of the distance from the airport. This finding is consistent with Alonso's study (1964).

Another finding is the privilege of the location closer to the airport since speed and agility become more important for some types of products to be shipped to markets outside the region (Kasarda, 1999). As a result, since the transportation costs of final products to be shipped overseas are higher than the transportation costs of raw materials, the location of the plant will be moved closer to the market. In this case, the airports will be the closest location to the oversea market. This finding is supported by early studies (Ratcliff, 1949; Forsby, 2004; and Flores-Fillol and Nicolini, 2006). Although all of the coefficients have a negative impact on the average manufacturing and warehouse land value, the comparison of the three coefficients indicates that industry and warehouse reacted to the presence of the airport, especially after the airport was proposed in 1991, because of the increased accessibility to oversea markets.

**Hedonic pricing model (multivariate regression analysis).**

The results of stepwise regression analysis of the manufacturing and warehouse land for these periods of time are shown in table VI.4. The F-statistics of the four equations show the result of the significance at the 5 percent level with 77.711 (1987),

22.512 (1995), 26.029 (2002), and 24.759 (2009). The adjusted R-squares of the four equations suggest the strong relationship between the dependent and independent variables for the 1987 equation with 0.822, and a weaker relationship for the 1995, 2002, and 2009 equations. The result of the weaker relationship between dependent and independent variables may be due to the small sample size of manufacturing and warehouse land in this quadrant.

Focusing on the period prior to the airport, the result of the equation indicates the significance of three independent variables, which include Dist.ST, Dist.BNTHWY, and Dist.REC. The coefficients of the three variables are -0.474, -2.427, and -0.486 respectively. Since all coefficients have negative signs, the results suggest that the prices of manufacturing and warehouse land would reflect higher prices closer to these factors, while the distance to direct access to main streets is the most important factor affecting the price of land, with a 242.7 percent decrease in price as the distance increases by 1 percent. Moreover, the result suggests that the price of land in this period also reflects a higher price closer to the main streets and the Bang Na-Trad Highway.

In 1995, after the future site of the airport was proposed, the results of the equation for this year indicate the significance of only two variables. These two variables and the coefficients are Dist.AIR (-1.256), and Dist.ST (-0.282). The result suggests that the prices of land are sensitive to the proposed airport site, which means the value of land would reflect higher prices close to the airport site. This evidence confirms that the market for manufacturing and warehouse land was reacting to the presence of the proposed airport and its privilege of high accessibility to store and ship the products overseas using air transportation. Moreover, the distance to direct access to main streets

is significant in this period with a negative impact on the value of manufacturing and warehouse land.

For the 2002 and 2009 equation, the results of the model indicate the same significant variables, Dist.CBD and Dist.ST, that enter the equation for each period of time. The coefficients of these two variables for the 2002 model are -3.018 and -0.271, while the coefficients of variables for 2009 model are -1.160 and -0.260. The results of these two models demonstrate that the distance to the Bangkok CBD is the most influential factor affecting the price of manufacturing and warehouse land. The negative sign on coefficient of Dist.CBD suggest that the prices of land would reflect higher prices closer to the Bangkok CBD. Similar to the Dist.ST, the results suggest that the values of land reflect higher prices closer to the direct access of the main street for both time periods.

Vacant Land

**Bid-rent model (simple regression analysis).**

For the final land use type in the northeast quadrant - vacant land - the analysis of variance for the three periods of time (table VI.3) shows that the F-statistics of 1995, 2002, and 2009 are 154.521, 118.321, and 62.934 with the significance at the 5 percent level. As a result, the high values of the F-statistic for the three periods of time are significant. These results suggest that all parameter estimates are nonzero, which means there is sufficient evidence to determine that the independent variable, the natural log of Dist.AIR, fits into the regression model to explain the change in the value of vacant land over the various times of the study.

Considering the results of the coefficient regression (table VI.3), the results show that the coefficients are -1.609 (1995), -1.390 (2002), and -1.047 (2009), with the

significant t-statistics of -12.431, -10.878, and -7.933. Therefore, the significance of the t-statistics determines that the slopes of all three dependent variables are not equal to zero.

As a result, the average commercial land value is sensitive to the distance to the airport, while the average commercial land value for 1995 is more sensitive to the distance to airport than the values for 2002 and 2009. These could be interpreted to indicate that the distance to the airport is affecting the high-density residential land value. Moreover, with negative coefficients, these results explain the negative impact of the distance to the airport on the average vacant land value over the time period of the study, which means the average vacant land value will decline with the increasing distance from the airport. The finding also supports the hypothesis of the study.

**Hedonic pricing model (multivariate regression analysis).**

The results of stepwise multivariate regression for the four periods of time are shown in table VI.4. The results of the F-statistics of the four equations are significant at the 5 percent level with the values of 129.804 (1987), 158.142 (1995), 107.502 (2002), and 69.093 (2009). Since the F- statistics of the four equations are significant, there is sufficient evidence to conclude that the natural log of all independent variables in each equation fits into the stepwise regression model. Moreover, the adjusted R- squares for each period of time are 0.651 (1987), 0.683 (1995), 0.554 (2002), and 0.499 (2009). The results of the adjusted R-square suggest that about 65 percent of the average vacant land value can be explained by the independent variables entered in the equation for year 1987. At the same time, 68 percent, 55 percent, and 50 percent of the average value of vacant land can be explained by the independent variables in the equation for years 1995, 2002, and 2009.

The result of the 1987 equation indicates the significance of four independent variables entered into the equation, which include Dist.CCS, Dist.ST, Dist.BNTHWY, and Dist.REC. The coefficients of these four variables are 1.758, -0.500, -0.1842, and -0.432 respectively. The result suggests that the distance to the Cha Cheng Sao CBD is the most highly sensitive to the change in prices of land in this period compared with other independent variables. Since the sign on the coefficient of Dist.CSS is positive, this would imply that the price of vacant land reflect higher prices farther from the CBD. Unexpectedly, the result of the positive sign on this variable may be affected by including other variables into the equation. However, the distance to accessibility of transportation networks and amenities still has positive impact on the prices of land.

Considering the result of the model after the proposal of the airport site, the result in this period indicates four significant variables in the equation. The variables and their coefficients are Dist.AIR (-1.099), Dist.CCS (0.924), Dist.ST (-0.391), and Dist.REC (-0.185). After the announcement of the new airport site, the market reacted, causing the price of vacant land in this quadrant to increase dramatically. The model implies that the price of land decreased by 109.9 percent as the distance to the airport site increased by 1 percent, which is the most sensitive variable reflecting on value of land compared to other variables. Moreover, the result still consists of the positive significance of the Cha Cheng Sao CBD, which affects the price of land by increasing about 92 percent as the distance to the Cha Cheng Sao CBD increases by 1 percent. Similar to Dist.ST and Dist.REC, the results suggest the higher price closer to the main street and recreational areas.

During the airport construction, the model of vacant land indicates three significant variables. These variables and their coefficients are Dist.AIR (-1.043), Dist.ST (-0.262), and Dist.REC (-0.301). The result confirms that the airport is still the most important factor affecting the price of vacant land just as in the previous time period, while other two independent variables, Dist.ST, and Dist.REC, still have a negative impact on land values as in the previous two time periods. One finding from this period is the insignificance of any CBD that affect the price of land.

The final result of the 2009 equation of vacant land indicates the significance of four variables that are entered into the equation. These four variables and coefficient are Dist.CBD (-2.352), Dist.ST (-0.318), Dist.BNTHWY (-1.765), and Dist.BCACC (0.129). The results of the coefficients indicate that the distance to the Bangkok CBD becomes significant at this time, with the most negative impact on the value of land. This would imply that the prices of land decreased by 235.2 percent as the distance to the CBD increased by 1 percent. Also, the distance to the direct access to the Bang Na-Trad Highway is the second important factor affecting the price of vacant land. The next influential factor affect on the prices of land is the distance to a main street, while the prices of vacant land reflect higher prices closer to the main street.

On the other hand, the distance to the New Bangkok-Chinburi Highway accesses are positively significant, which mean the prices of land reflect higher prices farther away from the highway access. Another finding for this period is the insignificance of the distance to the airport. It may be assumed that, including other independent variables into the equation, the distance to the airport becomes less important than those variables in the

equation. That means the effects of the distance to the CBD and accessibility become more important than distance to the airport.

Summary of Findings of the Northeast Quadrant

Considering the results of the bid-rent model and the stepwise regression analysis through the four time periods (1987, 1995, 2002, and 2009), five conclusions can be drawn for the northeast quadrant. First, the results of the bid-rent model confirm a property's location relative to the airport has an impact on the land value. These results consist of the negative impacts of the distance to the airport on the average land values for the four periods of time. Furthermore, the gradient for commercial land use is the steepest among six types of land uses. This result indicates that land value for commercial land use is most sensitive to the location of the airport, or has the strongest requirement for accessibility to the airport.

Second, the results of the bid-rent equations confirm that the bid rent gradients for six types of land use decline dramatically throughout the three time periods because of the Asian Financial Crisis and its impact on Thailand's economy in 1997. This financial crisis had a wide ranging impact throughout every business sector, which slowed down the business developments and investments, and caused a financial crisis for Thai government and the collapse of Thai currency (Baht). Therefore, Thailand's eighth and ninth national development and social development plans (1997-2001 and 2001-2006) shut down the project of the Suvarnabhumi Airport City. Although the financial crisis caused a slowdown of growth in Thailand, the results of bid rent suggest that commercial land use still outbid other types of land use in the locations close to the airport because of the advantage of the agglomeration economies and the high accessibility. That means the

commercial businesses, which include low-order and high-order retail and services, have the steepest bid rent gradients throughout the four periods of time because of the advantage of the agglomeration economies around the airport compared to residential and manufacturing land use.

In addition, in 1995, the resulting bid rent gradients of all types of land use were supported by Alonso's theory (1964), while the bid rent gradient of commercial land use is the steepest, the manufacturing land use is the second steepest, and the low-density residential land is the shallowest. Then, in 2002 and 2009, the low-density residential land was outbid by the manufacturing for the location closer to the airport. The explanation of this result is due to the general factors that impact choosing the location of industry - transportation cost and labor supply. Since most of the area in the northeast quadrant is agriculture and residential land with one limited highway accesses of the New Bangkok-Chonburi highway, this causes inconvenience for industrial businesses to ship products to market compared to other quadrants. Also, the sixth to ninth national economic development plans promote the area in Samut Prakarn province, south of the airport, to become an industrial zone. Therefore, the industrial businesses tend to relocate their plants to the area where the labor supplies are sufficient and government policies support their businesses.

Furthermore, since the statistical results of the bid rent model for this quadrant confirm the negative impact of the proximity to the airport on the urban land value for all six types of land uses throughout the three periods of time. The significance of the negative impact of the airport can be explained by the characteristics of the land use and geographical constraints of the area. Most of the land in the northeast quadrant has been

preserved for agriculture and as a flood plain area. At the same time, it is also in the direction of massive water flow from the north of Thailand during the rainy season, when water passes through this area before it flows out at the Gulf of Thailand. As a result of these geographical constraints, the prices of land in the northeast direction of the airport have not increased very much as compared to the other areas adjacent to the airport.

Since the area of the northeast quadrant is in the fringe area and very far from the Bangkok CBD, the distance to the city center cannot be overwhelmed by its proximity to the airport and also the nature of land itself. The airport has become the only center of the development in this quadrant, which supports Alonso's assumption of urban land market theory that the city has only one center. Therefore, the proximity to the airport is significantly reflected in the prices of land for this quadrant.

Another reason for the negative impact of the distance to the airport on the urban land values is the restrictions of the land use regulations and land use comprehensive plan of Bangkok, which preserved this area for agriculture land use (Appendix A, B, and C). As a result, developers cannot construct new buildings to exceed the capacity of the FAR provided by the city. Therefore, the density of new construction has been controlled by the land use regulation of agriculture land, while the area adjacent to the airport is still preserved for low-density residential land use, such as the area along King Kaeo Road and Lad Krabang Road.

The developments around the airport area have increased intensively along Lad Krabang Road in the area of Hua Takhea Community, where the King Mongkut's Institute of Technology has been located since 1971. The university has changed the land use pattern of the Hua Takhea community dramatically, while the growth of community

has occurred along the Pravej canal. After the completion of the university and the expansion of the existing Lad Krabang Road, the community has experienced increasing commercial and residential development in the area, while the street network has become an importance factor in attracting new developments instead of the canals. The development of commercial activities, such as the low-order retail businesses, is intensive in the area between the intersection of Lad Krabang Road and Chalong Krung Road through Lum Pra Tew canal. At the same time, multi-family units, such as apartment and dormitories, has been developed along the main streets, such as Chalong Krung and Lad Krabang Roads, which are close to the university. With the increased density in the area of the Lad Krabang sub center, these developments caused the price of land in this area to increase dramatically compared to the other areas in the northeast quadrant. Moreover, since Bangkok City has not had a good land use plan in the past thirty years to enforce the use of land, most of the developments usually occur along the transportation arterials, such as major streets and highways.

For the manufacturing and warehouse land use in this quadrant, the development of these activities prior to the airport tended to cluster along the major roadways, such as King Keao Road, Rom Klao Road, and Chalong Krung Road, and also spread throughout the northeast quadrant. In 1991, after the announcement of the airport, new manufacturing and warehouse activities moved closer to the airport along Lad Krabang Road, while some of the development clustered along Rom Klao Road. In 1978, the Industrial Estate Authority of Thailand established the Lad Krabang Industrial Estate, which is located along Chalong Krung Road, north of the airport. This industrial estate attracted more than a hundred new developments of manufacturing activities and also

resulted in the relocation of existing manufacturers in this area. With the advantages of the location closer to the airport and high accessibility, throughout the last thirty years competition for land among the manufacturing and warehouse developments has increased for these locations.. As a result of the intensity of the development around the airport for this quadrant, the statistical results of the bid-rent model confirm a negative impact of the proximity to the airport on the urban land values for the northeast quadrant.

Third, the results of stepwise multivariate analysis reveal the consistently negative impact of the distance to the airport on the prices of agriculture, high-density residential, and commercial land through the three periods of time (1995, 2002 and 2009), while other types of land use (low-density residential, manufacturing and warehouse, and vacant land) do not experience impact from the airport on the prices of land during these times. That is because the land market of high-density residential reacted to the announcement of the airport site and the newly available jobs at the airport to support the need of living places for new employees. In terms of commercial land use, the business activities tend to cluster around the airport to generate the agglomeration economies because of the presence of the airport location, while the passenger terminal can be determined as the core area.

Fourth, the results of stepwise multivariate regression analysis support the consistently negative significance of accessibility to the main streets. Since the privilege of the location close to the street provides high accessibility and high visibility to the transportation network, the price of land would reflect higher prices closer to the direct access to main streets.

Finally, in terms of the distance to the CBDs, the analysis results indicate that the distance to the Bangkok CBD is more important than the other two CBDs with the negative impact on the values of land for low-density residential as well as manufacturing and warehouse land. On the other hand, the results of the positive impact of the distance to the Bangkok CBD on high-density residential and commercial land are different from the hypothesis perhaps because of the small sample size for each model. Therefore, it is difficult to draw the conclusion from these models that the distance to the Bangkok CBD has a positive impact on the values of high-density residential land and commercial land.

**Southwest Quadrant**

The southwest quadrant of the airport includes two jurisdictions of Bangkok City and Samut Prakarn Province. This quadrant covers two districts -- Prawet and Pra Kha Nong of Bangkok City, and five districts -- Rachathewa, Bang Kaeo District, Bang Phi Yai, Bang Chalong, and Bang Pla of Samut Prakarn Province.

**Table VI.5: Log Linear Regression for Parameters of Bid-Rent Function, Southwest Quadrant**

| Land Use | 1995 | | | 2002 | | | 2009 | | |
|---|---|---|---|---|---|---|---|---|---|
| | b | t | F | b | t | F | b | t | F |
| **Agriculture** | 0.176 | 2.058 | 4.234 | 0.483 | 3.656 | 13.364 | 0.781 | 5.660 | 32.404 |
| **Low-Density Residential** | 0.593 | 7.246 | 52.507 | 1.102 | 9.379 | 87.965 | 1.059 | 9.996 | 99.922 |
| **High-Density Residential** | | | | 0.468 | 2.913 | 8.487 | | | |
| **Commercial** | -0.796 | -2.746 | 7.539 | | | | | | |
| **Manufacturing & Warehouse** | | | | 0.208 | 2.322 | 5.390 | 0.277 | 3.236 | 10.470 |
| **Vacant Land** | | | | 0.985 | 8.485 | 71.988 | 1.180 | 9.432 | 88.961 |

α = 5 percent level

Dependent variable is LN(Land Value)

Independent variable is LN(Distance to Airport)

**Table VI.6: Results of Stepwise Log Linear Multiple-Regression on Land Value by Land Use Type and Year, Southwest Quadrant**

| Land Use / Variable | Agriculture | | | | L-Density Residetial | | | | H-Density Residential | | | | Commercial | | | | Manufacturing & Warehouse | | | | Vacant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 |
| 1. Dist.AIR | | -0.296 | | | | | 0.489 | 2.091 | | | | | | -0.553 | | -0.299 | | -0.353 | | -0.278 | | -0.774 | | 0.392 |
| | | (-3.020) | | | | | (4.326) | (16.624) | | | | | | (-2.322) | | (-2.328) | | (-3.424) | | (-3.769) | | (-5.710) | | (3.881) |
| 2. Dist.CBD | -2.701 | | -1.363 | | -2.787 | | -1.199 | | | | | | -3.993 | | -1.459 | -1.439 | | | | | -3.464 | | -1.590 | -1.049 |
| | (-11.784) | | (-5.883) | | (-18.071) | | (-9.563) | | | | | | (-7.676) | | (-9.659) | (-8.979) | | | | | (-15.992) | | (-14.889) | (-8.369) |
| 3.Dist.SMP | | | | -0.950 | | | | | -1.250 | 0.686 | -0.433 | -0.409 | | | | | -1.764 | 0.624 | -0.487 | -0.890 | | | | |
| | | | | (-5.625) | | | | | (-2.862) | (3.584) | (-3.018) | (-2.811) | | | | | (-17.861) | (4.996) | (-5.706) | (-9.175) | | | | |
| 4. Dist.ST | -0.309 | -0.337 | -0.204 | -0.228 | -0.175 | -0.121 | -0.109 | -0.134 | | -0.184 | -0.135 | -0.162 | -0.288 | -0.124 | -0.208 | -0.187 | -0.207 | -3.830 | -0.261 | -0.247 | -0.333 | -0.392 | -0.215 | -0.235 |
| | (-11.555) | (-8.681) | (-7.290) | (-7.035) | (-8.334) | (-4.304) | (-4.752) | (-5.785) | | (-4.597) | (-4.623) | (-4.725) | (-5.463) | (-2.719) | (-7.954) | (-6.969) | (-8.217) | (-18.900) | (-17.346) | (-15.663) | (-12.504) | (-15.822) | (-14.302) | (-13.066) |
| 5. Dist.BNTHWY | -0.115 | -0.226 | -0.186 | -0.148 | -0.168 | -0.443 | -0.218 | -0.222 | | -0.536 | -0.159 | -0.206 | -0.220 | -0.405 | -0.293 | -0.314 | -0.241 | -0.582 | -0.398 | -0.340 | -0.251 | -0.585 | -0.402 | -0.405 |
| | (-3.095) | (-3.398) | (-3.686) | (-2.447) | (-6.870) | (-9.994) | (-6.448) | (-7.054) | | (-9.968) | (-4.042) | (-4.847) | (-4.093) | (-8.031) | (-10.157) | (-10.539) | (-9.518 | (-23.433) | (-22.141) | (-18.629) | (-10.973) | (-18.868) | (-21.342) | (-18.474) |
| 6. Dist.REC | | | | | -0.111 | -0.182 | -0.219 | 0.165 | | | -0.137 | | 0.378 | | | | | 0.164 | | | 0.126 | | -0.110 | -0.079 |
| | | | | | (-2.571) | (-3.975) | (-5.741) | (4.648) | | | (-2.086) | | (2.676) | | | | | (3.036) | | | (2.011) | | (-3.461) | (-2.217) |
| 7. Att.CANAL | -0.610 | -0.429 | -0.175 | -0.267 | | | | | | | | | | | | | | | | | | | | |
| | (-6.921) | (-4.275) | (-1.988) | (-3.090) | | | | | | | | | | | | | | | | | | | | |
| 8. Dist.BCACC | | | | 0.245 | | | | | | | | | | | | | | | -0.471 | | | | | |
| | | | | (2.205) | | | | | | | | | | | | | | | (-6.474) | | | | | |
| 9. Dist.BEACC | | | 0.467 | 0.290 | | | | | | | | | | | | 0.312 | | | 0.097 | 0.294 | | | 0.370 | 0.320 |
| | | | (4.688) | (3.182) | | | | | | | | | | | | (4.012) | | | (2.027) | (5.968) | | | (7.037) | (6.005) |
| 10. Dist.ALS | | | | | | | | -1.604 | | | | -0.327 | | | | | | | | | | | | |
| | | | | | | | | (-14.540) | | | | (-2.291) | | | | | | | | | | | | |
| Constant | 14.783 | 8.641 | 12.265 | 10.328 | 14.635 | 8.317 | 11.689 | 8.387 | 9.775 | 7.057 | 10.544 | 11.256 | 18.568 | 10.527 | 14.207 | 14.534 | 10.955 | 7.823 | 11.375 | 11.801 | 16.618 | 9.914 | 13.373 | 11.153 |
| F-Statistic | 89.550 | 21.675 | 20.521 | 18.880 | 338.590 | 53.214 | 83.194 | 78.860 | 8.189 | 33.442 | 15.310 | 13.793 | 36.761 | 27.629 | 7.289 | 38.866 | 167.860 | 137.505 | 137.246 | 103.491 | 166.123 | 156.270 | 195.359 | 113.778 |
| Ajusted $R^2$ | 0.560 | 0.272 | 0.327 | 0.387 | 0.771 | 0.207 | 0.418 | 0.390 | 0.324 | 0.448 | 0.276 | 0.258 | 0.749 | 0.365 | 0.553 | 0.510 | 0.705 | 0.580 | 0.539 | 0.478 | 0.597 | 0.409 | 0.602 | 0.537 |
| Sample Size | 287 | 222 | 202 | 171 | 401 | 602 | 574 | 611 | 16 | 121 | 151 | 148 | 49 | 140 | 174 | 183 | 210 | 495 | 584 | 560 | 446 | 673 | 643 | 584 |

Note: Significant at 5 percent level

Variables: 1. Distance to Airport (Dist.AIR), 2. Distance to Bangkok CBD (Dist.CBD), 3. Distance to Samut Prakarn CBD (Dist.SMP), 4. Distance to Nearest Major Street (Dist.ST)
5. Distance to Bang Na-Trad Highway (Dist.BNTHWY), 6. Distance to Recreation (Dist.REC), 7. Attach to Canal (ATT.CANAL), 8. Distance to Bangkok-Chonburi New Highway Access (Dist.BCACC)
9. Distance to Bangkok Eastern Outer Ring Highway Access (Dist.BEACC), 10 Distance to Airport Link Station (Dist.ALS)

Model: * 1987, Variables include Variable 2-7 * 1995, Variables include Variable 1-7 * 2002, Variables include Variable 1-9 * 2009, Variables include Variable 1-10

Agriculture Land

**Bid-rent model (simple regression analysis).**

The results of the analysis of variance of agriculture land use for the three time periods are shown in table VI.5. The F-statistics of the three nonlinear regressions are 4.234 (1995), 13.364 (2002), and 32.404 (2009). The results of all three models indicate the significance of the model. Therefore, the null hypothesis can be rejected. In other words, all three parameter estimates of the natural log of Dist.AIR in three equations are nonzero, and they all fit into the regression models in order to explain the change in the average agriculture land value.

In addition, the results of the regression coefficient of the natural log of Dist.AIR for all three equations are positively significant relative to the natural log of average agriculture land value (table VI.5). For 1995, 2002, and 2009, the coefficients of the natural log of Dist.AIR are 0.176, 0.483, and 0.781, while the t-statistics are 2.058, 3.656, and 5.660. These t-statistics indicate the significance of the slopes, which are not equal to zero at the significance of 5 percent level. The comparison of the slopes of the three models shows that the bid-rent curves have more slope in 2009 and are less steep over the time periods in 2002 and 2009. On the other hand, the significance of the positive sign of three coefficients is opposite to the hypothesis of the study, which should be negative. Therefore, the results of these positive coefficients indicate that the farther away from the airport, the higher the average land value. Also, other factors may impact average agriculture land value rather than airport in the southwest quadrant, which may cause the difference in the positive sign of those three coefficients.

**Hedonic pricing model (multivariate regression analysis).**

The results of the stepwise regression model of agricultural land use in the southwest quadrant are shown in table VI.6. The results of the equations for the four time periods indicate the significance of all four models at the 5 percent level, while the F-statistics of each year are 89.550 (1987), 21.675 (1995), 20.521 (2002), and 18.880 (2009). This suggests that all parameter estimates in the equations are statistically different from zero. In addition, the adjusted R-squares of the four models are 0.560 (1987), 0.272 (1995), 0.327 (2002), and 0.387 (2009). These results suggest that about 56 percent, 27 percent, 33 percent, and 39 percent of the average vacant land value in the 1987, 1995, 2002, and 2009 equations can be explained by the independent variables entered in each equation.

In the 1987 equation, the result of stepwise regression model indicates the significance of four variables, which include Dist.CBD, Dist.ST, Dist.BNTHWY, and Att.CANAL. The coefficients of these four variables are -2.701, -0.309, -0.115, and -0.610. The signs on coefficients match what was intuitively expected in this dissertation. In the time period prior to the airport, the prices of agricultural land are most sensitive to the Bangkok CBD rather than to any other factor. The result would imply that the price of agricultural land in this time period decreased by 207.1 percent as the distance to the Bangkok CBD increased by 1 percent. The second important factor that affects the price of agricultural land is the canals because the price for land adjacent to the canal is higher than for land located farther away from the canal. The other two accessibility variables also have a negative impact on value of land. The result suggests that the prices of agricultural land closer to the main street reflect a higher price than land father away.

Similar to the accessibility to the Bang Na-Trad highway, the result confirms that the price of the land would increase for land closer to the Bang Na-Trad Highway, while the distance to Bang Na-Trad highway has the least impact on the land value in this time period.

Considering the 1995 equation, the result indicates the significance of the four independent variables entered into the final step of the stepwise regression. The four significant variables and the coefficients are Dist.AIR (-0.296), Dist.ST (-0.337), Dist.BNTHWY (-0.226), and Att.CANAL (-0.429). The negative significance of all four variables in this period is similar to the previous model of 1987 with the same negative impact on the value of land. However, since the significance of the airport is entered into the equation, the result suggests that the prices of agricultural land in this time period reflect higher prices closer to the airport. The distance to the Bangkok CBD at this time becomes insignificant and then is dropped from the equation. The other three variables, Dist.ST, Dist.BNTHWY, and Att.CANAL, which impact the prices of land, are still the same with a negative impact from all of these variables. Since all of these provide the same negative impact on the value of land, the most important factor reflected in the prices of agricultural land is the canal, with 42.9 percent change in prices as the distance increases by 1 percent. Furthermore, the airport location at this time reflects that the prices of land decrease by 29.6 percent as the distance to the airport site increases by 1 percent.

During the airport construction period in 2002, the result of the stepwise regression model indicates five significant variables at the 5 percent level in the equation. The five significant variables and coefficients are Dist.CBD (-1.363), Dist.ST (-0.204),

Dist.BNTHWY (-0.186), Att.CANAL (-0.175), and Dist.BEACC (0.467). All four negative signs of the coefficient of Dist.CBD, Dist.ST, Dist.BNTHWY, and Att.CANAL match the expectation of this dissertation, with the price of land reflecting higher prices closer to those accessibilities. The results of the 2002 equation suggest that the prices of land are still most sensitive to the distance to the Bangkok CBD, with the prices decreasing around 136.3 percent as the distance increases by 1 percent. In addition, the distance to the main streets and the Bang Na-Trad highway slightly reflects the prices of agricultural land in this period by 20.4 and 18.6 percent as the distance increases by 1 percent. At the same time, the price of land is also reflected by the location adjacent to the canals. On the other hand, the positive sign on Dist.BEACC suggest the price of agricultural land would increase the farther the distance from access to the Bangkok Eastern Outer Ring Highway. As a result, the prices of land would increase by 46.7 percent as the distance increases by 1 percent. Moreover, the result of the equation for the year 2002 indicates the insignificance of the airport, which did not affect the price of agricultural land.

The result of the 2009 equation reveals six significant variables at the 5 percent level entered into the equation. The significant variables and coefficients are Dist.SMP (-0.950), Dist.ST (-0.228), Dist.BNTHWY (-0.148), Att.CANAL (-0.267), Dist.BCACC (0.245), and BEACC (0.290). The results of the equation confirm that access to the Bangkok CBD is still the most significant factor. Furthermore, the results of the model confirm the significance of the other three variables (Dist.ST, Dist.BNTHWY, and Att.CANAL) with the negative impact on the value of agricultural land. However, the results indicate the positive significance of two other variables -- Dist.BCACC and

Dist.BEACC and suggest increasing prices as the location moves farther away from these two highway accesses.

Low-Density Residential Land

**Bid-rent model (simple regression analysis).**

According to table VI.5, the analysis of variances of low-density residential land value is significant for the three periods of time for the southwest quadrant of the airport. The results of the F-statistic are 52.507, 87.965, and 99.922 for years 1995, 2002, and 2009 with the significance at the 5 percent level. Therefore, the results suggest rejection of the null hypothesis that the parameter estimates for all of these three models are not equal to zero. In other words, the natural log of the Dist.AIR for the low-density residential land fits into the regression model.

Next, the results and the comparison of the coefficient regression of all three years, as seen in table VI.5, will be discussed. The coefficient regressions of the three equations, which are 0.593 (1995), 1.102 (2002), and 1.059 (2009), are all positively significant with the t-statistic of 7.246, 9.376, and 9.996 respectively. Since the coefficients of all three periods of time are significant, the t-statistics indicate the significance of the slopes, which are not equal to zero at the significance of 5 percent level. These could be interpreted to indicate that the distance to the airport has an impact on the low-density residential land value for the southwest quadrant through the three time periods. However, the coefficients have different signs from the expectation in all three time periods. With the positive coefficient, these can explain that the value of the low-density residential land will increase with the increase in the distance from the

airport. Therefore, these unexpected results may be influenced by other exogenous factors to cause the change in the sign.

**Hedonic pricing model (multivariate regression analysis).**

In terms of low-density residential land in the southwest quadrant, the results of the four equations indicate the significance at the 5 percent level with the F-statistics of 338.590 (1987), 53.214 (1995), 83.194 (2002), and 78.860 (2009) (table VI.6). The results of the four models suggest that all parameter estimates in each model are not equal to zero. Moreover, the adjusted R- squares for each time period are 0.771 (1987), 0.207 (1995), 0.418 (2002), and 0.390 (2009). The results of the adjusted R-square suggest that about 77 percent of the average low-density residential land value can be explained by the independent variables entered in the equation for the year 1987, while 21 percent, 42 percent, and 39 percent of the average price of low-density residential land can be explained by the independent variables in the equation for the years 1995, 2002, and 2009.

For 1987, the results of the stepwise regression reveal four significant variables entered into the equation. The four variables and coefficients are Dist.CBD (-2.787), Dist.ST (-0.175), Dist.BNTHWY (-0.168), and Dist.REC (-0.111). The results indicate a negative impact on the price of land for all four variables, while the Dist.CBD is the most influential factor on the land value in this year, with the price of land decreasing by 278.7 percent as the distance increases by 1 percent from the Bangkok CBD. Also, the two accessibility variables, which are Dist.ST and Dist.BNTHWY, have a negative impact on the value as well. Finally, the least influential factor, Dist.REC, has impact on the price

of land by decreasing the price only 11.1 percent as the distance from the closest recreational area increases by 1 percent.

After the new airport site was proposed, the results of the 1995 model affirm significant variables entered into the equation, which include Dist.ST (-0.121), Dist.BNTHWY (-0.443), and Dist.REC (-0.182). The results suggest access to the Bang Na-Trad Highway is the most influential factor, which reflects the prices of low-density residential land rather than the other two variables. Furthermore, the prices of low-density residential land also reflect higher prices closer to main streets and recreational area, while the Dist.CBD is no longer significant in this time period. On the other hand, access to the airport at this time is insignificant as the low-density residential land around the airport was expropriated by the government to protect the residential land from noise pollution generated by the new airport.

Considering the period during the airport construction, the outcomes of the 2002 equation indicate five significant variables entered into the equation. The five variables and the coefficients include Dist.AIR (0.489), Dist.CBD (-1.199), Dist.ST (-0.109), Dist.BNTHWY (-0.218), and Dist.REC (-0.219). The results of the model consist of the significance of three variables, which are Dist.ST, Dist.BNTHWY, and Dist.REC. These three variables are negatively significant just as in the two previous models. In this time period, there are two new significant variables added into the equation from the previous year, namely Dist.AIR and Dist.CBD. The result suggests that access to the airport has a positive impact on the prices of low-density residential land, which means the price of land would reflect higher prices farther away from the airport.

The positive sign on the coefficient of Dist.AIR variable was changed because the Dist.AIR was included in the equation with the other variables. In other words, when all variables are combined in the equation, the significance of other variables may be more important than the airport, and that will cause a change in the sign of the coefficient of the airport. Also, the possibility of noise pollution from the future airport may weaken the market for residential land. This would lower the price of low-density residential land closer to the airport. In addition, access to the CBD at this time becomes the most significant variable to reflect the higher prices of land. The result implies that prices of low-density residential land decreased by 119.9 percent as the distance to the Bangkok CBD increased by 1 percent, which is the greatest change in the price of land compared to other variables.

For the 2009 equation, the results of the stepwise regression indicate the significance of five independent variables. The five significant variables and coefficients are Dist.CBD (2.091), Dist.ST (-0.134), Dist.BNTHWY (-0.222), Dist.REC (0.165), and Dist.ALS (-1.604). In this time period, the results of the model affirm that access to the airport is still significant with the positive impact on the value of low-residential land, and the price of land is most sensitive to this variable rather than to other variables. This would imply that the price of low-density residential land would increase by 209.1 percent as the distance to the airport increases by 1 percent. The explanation of this positive impact on the value of land is the same as for the previous year, which involves awareness of the noise pollution from the airplanes as well as the combination of influential variables and the airport. At the same time, the results of the equation affirm three significant variables, Dist.ST, Dist.BNTHWY, and Dist.REC, with a negative

impact on the prices of land for access to a main street and the Bang Na-Trad Highway, while the positive impact on land value was provided by access to the closest recreational area. Furthermore, a new significant variable, access to the airport link station, was entered into the equation at this time. The result suggests that the value of land would reflect higher prices by 160.4 percent as the land is located closer to the airport link station by 1 percent.

High-Density Residential Land

**Bid-rent model (simple regression analysis).**

The result of the analysis of variance is shown in table VI.5 with the value of the F-statistics for all three periods of time. The F-statistics indicate the significance of the model of the Dist.AIR on the average high-density residential land value. The results show that the F-statistic is not significant throughout the period of study, except for 2002, when the F-value is significant with 8.487. Since the F-statistic is significant only for the period during the construction of the airport, there is sufficient evidence to demonstrate that the independent variable, the natural log of Dist.AIR, fits into the regression model in order to respond to the change in average high-density residential land value in the southwest quadrant for the year 2002.

Considering the coefficient regression of the year 2002 (table VI.5), the result of the coefficient regression shows positively significance of 0.468 with a t-value of 2.913. The t-statistics of 2002 indicate the significance of the slope, which is not equal to zero at a significance of 5 percent level. Since the result of the regression coefficient of the natural log of Dist.AIR is positive, this could indicate that the distance to the airport has an impact on the high-density residential land value for the southwest quadrant, where the

increasing of the distance to the airport will increase the value of the high-density residential land. On the other hand, the sign of the coefficient in the equation shows the positive relationship, which is different from the hypothesis. Therefore, the high-density residential land value for 2002 may be influenced not only by the distance to the airport, but also by other exogenous factors that cause the difference in the sign and the insignificance of the model for 1995 and 2009. As a consequence, these factors will be examined in the following discussion of the stepwise multivariate regression analysis.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.6, the results of the four stepwise regression equations for high-density residential land are significant at the 5 percent level with the F-statistics of 8.189 (1987), 33.442 (1995), 15.312 (2002), and 13.793 (2009). Also, the adjusted R-squares for the four periods of time are 0.324 (1987), 0.448 (1995), 0.276 (2002), and 0.258 (2009). This means the average high-density residential land value is about 32 percent for year1987, 45 percent for year 1995, 28 percent for year 2002, and 26 percent for year 2009 by all significant independent variables entered into the equation for each time period.

For the time prior to the construction of the airport, the result of the 1987 equation indicates only one variable is significant - Dist.SMP with the coefficient of -1.250. The result of the model suggests that access to the Samut Prakarn CBD is only one factor that reflects higher prices of land by decreasing prices by about 125 percent as the distance to the Samut Prakarn CBD increases by 1 percent.

In addition, the results of the stepwise regression analysis for 1995 reveal three significant variables entered into the equation for this period. The three variables and the

coefficients are Dist.SMP (0.686), Dist.ST (-0.184), and Dist.BNTHWY (-0.536). The result suggests that the Dist.SMP rather than other variables is the most influential factor affecting the prices of land. However, the positive sign on the coefficient of Dist.SMP suggests that the prices of high-density residential land reflect higher prices farther away from the Samut Prakarn CBD. As a result, prices of high-density residential land increase by 68.6 percent as the distance to the Samut Prakran CBD increases by 1 percent. On the other hand, the signs on the other two coefficients of Dist.ST, Dist.BANTHWY indicate the negative impact of these variables on the price of land. In other words, the price of land would increase for land that is closer to the access to main streets and the Bang Na-Trad Highway.

The results of the 2002 equation reveal the significance of four variables entered into the equation. The four variables and the coefficients are Dist.SMP (-0.433), Dist.ST (-0.135), Dist.BNTHWY (-0.159), and Dist.REC (-0.137). The results of the model affirm the negative significance of three variables, which are Dist.SMP, Dist.ST, and Dist.BNTHWY, while the prices of land are still most sensitive to the distance to the Samut Prakarn CBD, just as in the previous model. At the same time, the new significant independent variable, Dist.REC, is entered into the equation with the coefficient of -0.137. This implies that the prices of land would reflect higher prices closer to the nearest recreational area.

Finally, in the 2009 equation the results of the stepwise regression indicate four significant variables entered into the equation, which include Dist.SMP (-0.409), Dist.ST (-0.162), Dist.BNTHWY (-0.206), and Dist.ALS (-0.327). The sign on the coefficients match what was intuitively expected by the dissertation's hypothesis. All signs are

negative. While all of the variables appear negatively significant in the model, the variable Dist.SMP is the most consistently significant in the correct expected sign. This would imply that, after the opening of the airport, the prices of high-density land would reflect higher prices closer to the Samut Prakarn CBD. While the second important variable affecting the prices of land is Dist.ALS, the result of this variable suggest that the price of land would decrease by 32.7 percent as the distance to the closest airport link station increases by 1 percent. Similarly, the access to the main street and the Bang Na-Trad highway are consistently significant with a negative impact on the prices of high-density residential land. This would imply that the prices of high-density residential land reflect higher prices closer to the access to main streets and the Bang Na-Trad highway.

Commercial Land

**Bid-rent model (simple regression analysis).**

The result of the analysis of variance for the commercial land value of the southwest quadrant is shown in table VI.5. The results indicate that the model of the regression analysis is significant only for the year of the proposed airport site in 1995 with the F-statistic of 7.539. However, the F-statistic of the year 2002 and 2009 are both not a significant response to the distance to the airport. That means only the natural log of average commercial land values for the year 1995 fit the model.

In addition, the coefficient regression result of the year 1995 is shown in the table VI.5. The result shows negative significance for the coefficient of 1995 with -0.796 and the t-statistic of -2.746, which means the slope of the natural log of the average commercial land value of 1995 is not equal to zero. Since the coefficient of the natural log of commercial land value is negative, the interpretation of the results demonstrates

that the average land value of commercial land will increase with the decreasing distance from the airport. However, the results of the coefficients of both 2002 and 2009 are not significant. This finding suggests that other exogenous factors may cause the significance of the distance to the airport variable to become insignificant, which this study will explore in the following analysis.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.6, the results of the stepwise multivariate regression analysis of the average commercial land value for four periods of time (1987, 1995, 2002, 2009) indicate the significance of the models at the 5 percent level with the F-statistics in order of 36.761, 27.629, 7.289, and 38.866, while the adjusted R-squares for four periods of time are 0.749 (1987), 0.365 (1995), 0.553 (2002), and 0.510 (2009). This means the average commercial land value is about 75 percent for 1987, 37 percent for 1995, 55 percent for 2002, and 51 percent for 2009 by all significant independent variables in the equation for each time period.

The results of the stepwise regression for the 1987 equation indicate four significant variables entered into the equation. These four significant variables with coefficients are Dist.CBD (-3.993), Dist.ST (-0.288), Dist.BNTHWY (-0.220), and Dist.REC (0.378). The signs on the coefficients match what was intuitively expected in the hypothesis of the dissertation, except for the Dist.REC. The variable Dist.CBD is the most important factor with the negative impact on the prices of commercial land at this time. The result would imply that the prices of commercial land decreased by 399.3 percent as the distance to the Bangkok CBD increased by 1 percent. In terms of accessibility to transportation networks, the two variables of Dist.ST and Dist.BNTHWY

appear negatively significant, which means the prices of commercial land reflect a higher price closer to direct access to main streets and the Bang Na-Trad highway. On the other hand, the positive sign on the Dist.REC suggest that the prices of land would reflect higher price farther away from the recreational areas.

After the site of new airport was proposed, the results of the 1995 equation reveal the significance of three variables entered into the stepwise regression equation. The three significant variables and coefficients are Dist.AIR (-0.553), Dist.ST (-0.124), and Dist.BNTHWY (-0.405). The signs on the three coefficients suggest the negative impact on the prices of land, while the prices of land are most sensitive to the accessibility to the new airport site rather than to the other two variables. The result implies that the prices of land at this time decreased by the 55.3 percent as the distance to the new airport site increased by 1 percent. Furthermore, the Dist.ST and Dist.BNTHWY variables provide a negative impact on the prices of land. The results suggest that in 1995 the prices of commercial land would reflect higher prices closer to the direct access to main streets and the Bang Na-Trad Highway.

Considering the 2002 equation, the results of the stepwise regression analysis indicate three significant variables, which include Dist.CBD (-1.459), Dist.ST (-0.208), and Dist.BNTHWY (-0.293). The results also indicate that the signs on all coefficients are negative, which matches what was intuitively expected by the dissertation hypothesis. The prices of land at this time appear to reflect higher prices close to the Bangkok CBD, while the distance to the airport is not significant during the construction period. Also the other two variables, Dist.ST and Dist.BNTHWY, are consistently significant with a negative impact on the prices of land, the same as in the previous model.

After the opening of the new airport, the results of the 2009 equation reveal five significant variables entered into the stepwise regression equation. The five variables and coefficients are Dist.AIR (-0.299), Dist.CBD (-1.439), Dist.ST (-0.187), Dist.BNTHWY (-0.314), and Dist.BEACC (0.312). The signs on the coefficients match what was expected by this dissertation with negative signs, except for the Dist.BEACC variable, which appears to have an unexpected positive sign. The results suggest that in 2009 the prices of commercial land are the most sensitive to the distance from the airport. This would imply that prices of commercial land decrease by 143.9 percent as the distance to the Bangkok CBD increases by 1 percent, while the other two variables of Dist.ST and Dist.BNTHWY also appear to have a negative impact on prices of commercial land. However, since the Dist.BECAA variable is positively significant, this suggests that the prices of commercial land in this time period reflect higher prices farther away from access to the Bangkok Eastern Outer Ring Highway. Moreover, the result indicates the negative significance of the Dist.AIR, while the prices of land would reflect higher prices closer to the airport.

Manufacturing and Warehouse Land

**Bid-rent model (simple regression analysis).**

In terms of bid rent models, the only variable of the distance to the airport will be entered into the model as an independent variable for 1995, 2002, and 2009. The results of the ANOVA, shown in table VI.5, indicate that the models are significant for two time periods -- during the airport construction (2002) and after the airport opening (2009). The F-statistics are 5.390 for 2002 and 10.470 for 2009, which means the null hypothesis can be rejected. Therefore, both parameter estimates for the natural log of Dist.AIR in

the equations are nonzero, and they all fit in to the regression models in order to explain the change in the average manufacturing and warehouse land values for 2002 and 2009.

The coefficient regressions of the natural log of Dist.AIR for all three periods of time are shown in table VI.5. The results of two time periods of the study, 2002 and 2009, are positively significant. The coefficients of the natural log of Dist.AIR are in the order of 0.208 and 0.277, while the t-statistics are 2.322, and 3.236 for 2002 and 2009. These t-statistics indicate the significance of the slope, which is not equal to zero at a significance of 5 percent level. As a result, all three t-statistic tests suggest that the average manufacturing and warehouse land value for both years are more sensitive to the distance from the airport than 1995.

However, the positive sign of the coefficient for both years is quite different from the expectation of the hypothesis to see a negative sign. Although the results indicate a positive sign for the coefficient, the average land value of manufacturing and warehouse land will increase as the distance from the airport increases. In terms of the comparison of the slopes for both years, the results indicate that the average manufacturing and warehouse land value for year 2009 are more sensitive to the distance from the airport than in year 2002. As a result, some exogenous factors may have caused the change in the sign of the coefficient for both year, or some factors other than the distance to the airport may cause the sensitivity of the average manufacturing and warehouse.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.6, the results of the stepwise regression analysis of manufacturing and warehouse land value for the four models of 1987, 1995, 2002, and 2009 indicate the significance at the 5 percent level of all four models with the F-

statistics of 167.860, 137.505, 137.246, and 103.491. The results suggest that all parameter estimates in all four models are not equal to zero. Additionally, the results of the adjusted R-squares for all four models are 0.705 (1987), 0.580 (1995), 0.539 (2002), and 0.478 (2009). The results of the adjusted R-square suggest a high relationship between dependent and independent variables for each model. As a result, about 71 percent of the average vacant land value can be explained by the independent variables entered in the equation for year 1987, while the 58 percent, 54 percent, and 48 percent of the average price of manufacturing and warehouse land can be explained by the independent variables in the equation for the years 1995, 2002, and 2009.

The results of the 1987 equation for the period prior to the new airport reveal three significant variables at the 5 percent level entered into the equation. The three significant variables and coefficients for this time period are Dist.SMP (-1.764), Dist.ST (-0.207), and Dist.BNTHWY (-0.241). The results suggest that before the new airport the prices of manufacturing and warehouse are most sensitive to access to Samut Prakarn CBD, while the negative sign on the coefficient implies that the prices of land reflect higher prices closer to the Samut Prakarn CBD. Similar to the other two variables, Dist.ST and Dist.BNTHWY, the results suggest the higher prices of land are reflected by the location closer to the main street and Bang-Na Trad highway.

For the 1995 equation, the results of the stepwise regression indicate five significant variables entered into the equation. The five variables and coefficients include Dist.AIR (-0.353), Dist.SMP (0.624), Dist.ST (-3.830), Dist.BNTHWY (-0.582), and Dist.REC (0.164). The results affirm the same significant variables, Dist.SMP, Dist.ST, and Dist.BNTHWY, as in the previous model. As a result, the sign on the

coefficient of Dist.SMP shows positive, which is different from the previous model, while the others are still the same. The two new variables added into the equation for this time period are Dist.AIR, and Dist.REC. The result suggests that, after the announcement of the new airport site, the price of land was influenced by the accessibility to that site. Therefore, this would imply that the value of land in this year reflects higher prices closer to the airport. In addition, the results of this model suggest that the prices of land would increase as the land is located farther away from recreational areas.

During the airport construction period, the results of the 2002 equation reveal five significant variables entered into the stepwise regression equation, which include Dist.SMP (-0.487), Dist.ST (-0.261), Dist.BNTHWY (-0.398), Dist.BCACC (-0.471), and Dist.BEACC (0.097). The results for this period suggest that the prices of manufacturing and warehouse land are most sensitive to the accessibility to the Samut Prakarn CBD rather than other variables. With the negative significance of the variable, this would imply that the prices of land decreased by 48.7 percent as the distance to the Samut Prakarn CBD increased by 1 percent. Moreover, the second important factor is the Dist.BCACC variable, which suggests that the prices of land reflect higher prices closer to the new Bangkok-Chonburi highway access. Similarly, the results of the significance of the Dist.ST and Dist.BNTHWY still have negative impacts on the values of land. Finally, with the new significant variable of Dist.BEACC, the results suggest that the prices of land would increase slightly by about 9.7 percent as the location of land increased in distance by 1 percent from the access of the highway.

After the opening of the airport, the results of the 2009 equation indicate the significance of five variables entered into the equation, which include Dist.AIR (-0.278), Dist.SMP (-0.890), Dist.ST (-0.247), Dist.BNTHWY (-0.340), and Dist.BCACC (0.294). The result suggests that the significance of Dist.SMP, Dist.ST, and Dist.BNTHWY have the same negative impact on the prices of land, while Dist.BEACC appear to have a positive impact, the same as in the previous model. In this time period, access to the new airport becomes significant with a negative impact on the prices of manufacturing and warehouse land. In other words, after the opening of the new airport the prices of land reflect higher prices closer to the airport.

Vacant Land

**Bid-rent model (simple regression analysis).**

The results of the model for the average vacant land value for the three time periods in the southwest quadrant are represented in the ANOVA table in table VI.5. The results show the significance of the models for the years 2002 and 2009 with the F-statistic of 71.988 and 88.961 at the 5 percent level. The significance of both years indicates that the two parameter estimates of the natural log of average vacant land value are not equal to zero. That means the distance to the airport variable for 2002 and 2009 are fitted into the model to describe the change in the average vacant land value.

The next consideration is the result of the coefficient regression of these two time periods (table VI.5), which are 0.985 and 1.180 with the t-statistic of 8.485 and 9.432 respectively. These results indicate the significance of the slope at 5 percent level, which means the slope of both periods of time is not equal to zero. However, the significance of the coefficients has a positive relationship to the distance to the airport, which is different

from the hypothesis of this study. The positive coefficients indicate that the average vacant land value will increase with the increase in distance from the airport. Since the coefficient of the Dist.AIR for year 2009 is higher than 2002, it also indicates that the average vacant land value for 2009 is more sensitive to the distance to the airport rather than in the year 2002. Furthermore, since the positive sign of the coefficients for both years shows different results from the hypothesis, it can be assumed that exogenous factors other than the distance to the airport affect the change in sign and make it different from the hypothesis of this study.

**Hedonic pricing model (multivariate regression analysis).**

According to the results of the stepwise regression model of vacant land in table VI.6, analysis of the F-statistics for the four periods of time suggests the significance of the models at the 5 percent level with the F-statistics of 166.123 (1987), 156.270 (1995), 195.359 (2002), and 113.778 (2009), while the results of the adjusted R-square of the four periods of time are 0.597, 0.409, 0.602, and 0.537. Since the F-statistics are significant for these periods, it is possible to reject the null hypothesis. Therefore, the results confirm that all parameter estimates in the four models are not equal to zero. These results indicate that the set of the independent variables of each year significantly represent the factors affecting vacant land value in the southwest quadrant.

The results of the 1987 equation indicate the four significant variables entered into the stepwise regression analysis. The four significant variables and coefficients are Dist.CBD (-3.464), Dist.ST (-0.333), Dist.BNTHWY (-0.251), and Dist.REC (0.126). The results of the model suggest that in the time prior the airport, the prices of vacant land are most sensitive to the accessibility to the Bangkok CBD that other factors. The

results demonstrate that the prices of land decreased by 346.4 percent as the distance from the Bangkok CBD increased by 1 percent. In terms of accessibility to transportation network, the results of the stepwise regression analysis suggest the negative impact of the accessibility of the transportation networks on the prices of land. In other words, the prices of land would reflect higher prices closer to the direct access of the main streets and Bang Na-Trad Highway. However, the positive sign on the coefficient of Dist.REC suggests the prices of vacant land would increase as the vacant land is located farther away from the recreational areas.

For the 1995 equation, the results of the stepwise regression reveal three significant variables entered into the equation, which include the Dist.AIR (-0.774), Dist.ST (-0.392), and Dist.BNTHWY (-0.585). After the new airport site was proposed, the prices of vacant land are most sensitive to access to the future airport location. As a result, the prices of land decreased by 77.4 percent as the distance to the future airport site increased by 1 percent. Similar to the results of the previous 1987 model, direct access to the main streets and Bang Na-Trad highway still has a negative impact on the changes in the value of land.

During the construction of the airport, the results of the model indicate five significant variables entered into the equation. The five variables and coefficients are Dist.CBD (-1.590), Dist.ST (-0.215), Dist.BNTHWY (-0.402), Dist.REC (-0.110), and Dist.BEACC (0.370). The results suggest the Dist.CBD is the most influential factor affecting the value of land during the construction period, while access to the airport is not significant at this time. The two variables of accessibility to transportation networks, Dist.BNTHWY and Dist.ST, still have negative impact on the value of land, while the

new variable, Dist.BEACC, is positively significant with the prices of land reflecting higher prices farther away from the nearest access to the Bangkok Eastern Outer Ring highway. Furthermore, the least sensitive factor affecting the prices of land is Dist.REC. With a positive sign on the coefficient, this would imply that the prices of land increased by only 11 percent as the distance from the nearest recreational area increased by 1 percent.

For the last model, the 2009 equation, the results indicate six significant variables entered into the equation. The six significant variables and coefficients are Dist.AIR (0.392), Dist.CBD (-1.049), Dist.ST (-0.235), Dist.BNTHWY (-0.405), Dist.REC (-0.079), and Dist.BEACC (0.320). The results of the model suggest that access to the Bangkok CBD is still the most influential factor affecting the prices of land. Moreover, after the opening of the airport, access to the airport becomes significant with a positive sign on the coefficient. The positive sign on the coefficient of the Dist.AIR variable is opposite from the expectation of the dissertation hypothesis. However, this result implies that the prices of vacant land reflect higher prices farther away from the airport location. The unexpected sign on the coefficient of Dist.AIR variable is due to noise pollution from the airport that causes cheaper prices of land closer to the airport. Another reason is that influential factors other than the access to the airport have more impact on the prices of land. The results of accessibility to transportation networks, Dist.ST and Dist.BNTHWY, still have negative impact on the vacant land value, while the Dist.BEACC is still positively significant, like the previous model. Similar to the Dist.REC, the effect of access to the nearest recreational area still has a negative impact

on the values of land, which are slightly changed by 7.9 percent when the distance to the nearest recreational area is increased by 1 percent.

Summary of Findings of the Southwest Quadrant

The analysis results of bid-rent model and stepwise multivariate analysis for all types of land use throughout the four periods of time can be summarized by five findings. First, for the bid-rent model, the distance to the airport has a positive impact on the values of all land use types except for the commercial land value in 1995, which has a negative impact. The results suggest the values of agriculture land (1995, 2002, 2009), low-density residential land (1995, 2002, 2009), high-density residential land (1995, 2002), manufacturing and warehouse land (2002, 2009), and vacant land (2002, 2009) command higher prices farther away from the airport, while the result of the commercial land value (1995) would reflect higher prices of commercial land closer to the airport site. This result may be a reaction to the announcement in 1995 of the future airport site. For other types of land uses, the positive impact of the distance to the airport seems to be unusual since this result occurs throughout the three periods of time after the site of the airport was proposed.

Moreover, the results indicating the positive impact of the distance to the airport on the urban land value can be overwhelmed by the accessibility of transportation (Bang Na-Trad Highway), Bangkok CBD, Samut Prakarn CBD, and the land use comprehensive plan of Bangkok City and Samut Prakarn province. Since the Bang Na-Trad highway is the first highway that connects the Bangkok metropolitan area and the eastern part of Thailand, the land along the highway had been developed intensively with

various kinds of land use activities, such as industrial and warehouse activities, low and high-order of retail businesses, and low and high-density residential developments.

In 1983, the first stage expressway system was opened to connect Din Daeng and Bang Na. This expressway provides a connection between the northern and eastern regions and bypasses traffic congestion in the metropolitan area. With increasing transportation accessibility to the Bang Na area, this has resulted in the development of commercial activities clustered along the Bang Na-Trad highway from the starting point at the intersection of Bang Na-Trad Highway (the end of the first stage expressway system) and Sukhumvit Road, through the intersection of Bang Na-Trad and Srinagarindra Road and extending along the highway with declining intensity of the development.

Furthermore, with the increased transportation accessibility between Bang Na and the Bangkok metropolitan area, new residential development has expanded to the area along the Bang Na- Trad highway. Mostly the residential development along the Bang Na-Trad highway are luxury-housing units for middle and high-income people who prefer to have more land with cheaper prices. Since the area between the two intersections has been defined as the fastest growth community in Bangkok, the land competition is very high compared to other areas in this quadrant. Therefore, with the increased transportation accessibility, these results reflect higher prices of land along the Bang-Na Trad highway and major transportation arterials, such as Srinagarindra Road, Sukhumvit Road, and Teparak Road, where the developments are clustered intensively along these arterial lines, compared to the area around the airport.

In 1984, Ramkamkeang University opened a second campus at Bang Na-Trad (Km.8). New commercial and residential activities have been attracted to the university area to meet the needs of students and staff. In this case, the development of the low-order retail businesses, such as restaurants, copy centers, grocery stores, and supermarkets tend to cluster around Ramkamheang University at Bang Na and are surrounded by high-density residential units, such as apartments, condominiums, and dormitories.

In 1995, Assumption University opened the Suvarnbhumi campus at Bang Na-Trad (Km. 23). Similar to Ramkamheang University at Bang Na campus, after the opening of the new campus new commercial and residential developments were attracted to the new campus and along the Bang Na-Trad highway. The opening of the two campuses has changed the patterns of land use and the prices of land along the Bang Na-Trad Highway. The competition for land along the highway has been intensive, and this has caused the prices of land to increase rapidly in the last 30 years. Since the lands along the Bang Na-Trad highway had been developed for many years before the new airport arrived, the prices of land around the airport could not overwhelm the prices of land along the Bang Na-Trad highway.

Furthermore, the impact of the Bangkok and Samut Prakarn CBDs may affect higher prices of land rather than the proximity to the airport because of the high concentration of the agglomeration economies in the core area of these two CBDs. According to the land use comprehensive plan of Bangkok city (Appendix A and B), Samut Prakarn province land use regulation (Appendix D) and building codes, these factors may play an important role and are reflected in the prices of land. The land use

comprehensive plan of Bangkok and Samut Prakarn province indicate the area along the Bang Na-Trad highway between Sukhumvit Road and Srinakarindra as commercial land use zoning (red) and is surrounded with the medium-density residential land use zoning (brown). Therefore, the zoning regulation and building codes of these two types of land use allow developers to build their properties with more density (floor area ratio) compared to the area around the airport, especially the area along King Kaeo Road, which is indicated as the commercial land use zone.

However, since the area along King Kaeo Road is close to the airport, there are many restrictions, such as land use regulations and building codes that control the height of the buildings and the density of the developments for safety of flights. These regulations are concerned not only with the land use regulations, but also with the airport land use regulations. Therefore, the regulatory control of the area close to the airport and the lower density of developments may reflect lower prices of land in the vicinity of the airport and become lower than the area closer to Bangkok and Samut Prakarn CBD and along Bang Na-Trad highway.

Second, the results of the stepwise regression analysis support the negative impact of the distance to the airport on the values of agricultural, commercial, manufacturing and warehouse, and vacant land for the 1995 period. The values of land reflect higher prices closer to the airport site. These results quite clearly demonstrate that the market was reacting to the announcement of the airport site and was valuing high-accessibility to the airport in such a way that a location closer to the airport was worth more than a location farther away.

Third, after the opening of the airport, the results of stepwise regression analysis suggest the negative impact of the airport on the values of commercial land as well as manufacturing and warehouse land, while the distance to the airport has a positive impact on the values of low-density residential. The result of the positive impact on the value of low-density residential land can be explained by the effects of the noise pollution, regulation controls for runway use, and landing and takeoff schedules, which influence residents to move in the opposite direction from the airport expansion. This result causes the decline in residential land value around the airport, while the effects might shift the use of land to higher development rent activities such as commercial or manufacturing and warehouse land use. Therefore, the prices of land for commercial as well as manufacturing and warehouse land use might increase more than pre-development prices.

Fourth, the Bangkok CBD and Samut Prakarn CBD are not significant for every type of land use throughout the four periods of time. However, in terms of the impact of the Bangkok CBD, the results indicate that the distance to the Bangkok CBD has a negative impact on the value of agricultural, low-density residential, commercial, and vacant land, while the distance to the Samut Prakarn CBD has a negative impact on the values of high-density-residential as well as manufacturing and warehouse land. Accessibility to the two CBDs is the strongest influencing factor affecting the prices of all types of land. As a result, in terms of agricultural land, the negative significance of the distance to the Bangkok CBD suggests that farmers prefer to bid higher for land close to their market, and Bangkok is the biggest market in the country. Thus, the land generates larger profits by reducing the cost of transportation.

In terms of low-density residential land, households determine their residential location based on the trade-off between the cost of commuting and land cost. Therefore, the prices of low-density residential land would decrease with the increasing distance to the Bangkok CBD. For commercial land, the Bangkok CBD is the most preferable place for businesses. The presence of agglomeration economies in the CBD provides the maximum profit to the business as reflected in the highest land values. For the manufacturing and warehouse land use, the value of land would reflect higher prices closer to Samut Prakarn CBD. Since the Sixth Five-Year National Economic and Social Development Plan (1987-1991) intended to promote the Eastern Seaboard Development Plan, the plan promotes Samut Prakarn Province as an industrial city. Many manufacturers and warehouses are attracted to the area because of lower transportation costs for shipping products to markets, while at the same time the location is closer to the Eastern Seaboard, Suvarnabhumi International Airport, and the market places in Bangkok and vicinity. As a result, the high concentration of the manufacturers and warehouses reflect the higher prices of land closer to the Samut Prakarn CBD. With the increasing number of manufacturers in Samut Prakarn Province, this result also causes increasing employment in the area. Consequently, high-density residences, such as condominiums and service apartments, also increase to support the new residents. This result would reflect higher land value of the high-density residential land closer to the CBD.

Finally, the findings from the stepwise regression analysis reveal that accessibility to transportation networks such as main streets and the Bang Na-Trad highway are important factors providing negative impacts on the prices of all types of land use. In terms of the low and high-density residential land use, the explanation of the significant

results throughout the four periods is that the location of the residential land close to the transportation network provides higher accessibility and convenience for residents to travel around the region. The residents' satisfaction is based on the utility maximization. This would reflect higher prices of land closer to the transportation network. In terms of commercial businesses, low-order retail businesses tend to cluster along the main streets, such as; Udom Suk, Srinagarindra, and Theparak Streets in the vicinity of the airport, while the high-order retail businesses tend to cluster along the Bang Na-Trad highway for easy accessibility. As a result of the high concentration of low and high order retail businesses, the values of commercial land would reflect higher prices closer to the transportation networks. Moreover, in terms of the manufacturing and warehouse land, most industries, warehouses, and terminal facilities tend to locate along major transportation networks, such as King Kaeo Street, Theparak Street, and the Bang Na-Trad Highway, because of the high accessibility to deliver goods to the markets and minimize transportation costs. Therefore, the value of manufacturing and warehouse land would reflect higher prices closer to direct access to the transportation network.

**Southeast Quadrant**

The final study area is the southeast quadrant. Much of this quadrant is in the Samut Prakarn Province and includes eight districts: Srisa Chorakhe Noi, Rachathewa, Nong Pru, Bang Chalong, Bang Pla, Bang Sao Thong, Srisa Chorakhe Yai, and Bang Bo.

**Table VI.7: Log Linear Regression for Parameters of Bid-Rent Function, Southeast Quadrant**

| Land Use | 1995 | | | 2002 | | | 2009 | | |
|---|---|---|---|---|---|---|---|---|---|
| | b | t | F | b | t | F | b | t | F |
| **Agriculture** | | | | 0.699 | 6.156 | 37.900 | 0.294 | 2.482 | 6.120 |
| **Low-Density Residential** | 0.579 | 7.833 | 61.359 | 0.663 | 5.937 | 35.245 | 0.771 | 5.840 | 34.111 |
| **High-Density Residential** | | | | | | | | | |
| **Commercial** | | | | 2.760 | 3.139 | 9.851 | 2.784 | 3.833 | 14.693 |
| **Manufacturing & Warehouse** | 0.839 | 3.862 | 14.914 | 1.604 | 7.669 | 58.808 | 0.951 | 3.298 | 10.875 |
| **Vacant Land** | 1.204 | 3.341 | 11.165 | | | | 0.901 | 2.308 | 5.325 |

$\alpha$ = 5 percent level

Dependent variable is LN(Land Value)

Independent variable is LN(Distance to Airport)

**Table VI.8 : Results of Stepwise Log Linear Multiple-Regression on Land Value by Land Use Type and Year, Southeast Quadrant**

| Land Use / Variable | Agriculture | | | | L-Density Residetial | | | | H-Density Residential | | | | Commercial | | | | Manufacturing & Warehouse | | | | Vacant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 | 1987 | 1995 | 2002 | 2009 |
| 1. Dist.AIR | | | 0.677 | | | 0.369 | | | | | | | | | | | | | | | | | | |
| | | | (7.249) | | | (4.882) | | | | | | | | | | | | | | | | | | |
| 2. Dist.CBD | | | | | | | | | - | | | | - | | | | | | | | | | | -4.537 |
| | | | | | | | | | | | | | | | | | | | | | | | | (-2.848) |
| 3. Dist.MMBP | | 0.524 | | | -0.501 | 0.534 | | | - | | | | - | | | | | | | | | | | |
| | | (2.335) | | | (-8.052) | (3.903) | | | | | | | | | | | | | | | | | | |
| 4.Dist.CCS | -3.038 | -2.201 | | | | | | -1.649 | - | | | | - | | | | | | | | | | 8.048 | |
| | (-3.536) | (-2.971) | | | | | | (-2.864) | | | | | | | | | | | | | | | (6.889) | |
| 5. Dist.ST | -0.393 | -0.344 | -0.238 | -0.311 | | -0.155 | -0.261 | -0.309 | - | -0.132 | -0.172 | -0.180 | - | | | | | -0.199 | -0.153 | -0.191 | -0.474 | -0.319 | | |
| | (- 7.493) | (-7.493) | (-9.608) | (-10.179) | | (-3.455) | (-6.341) | (-5.737) | | (-2.690) | (-4.410) | (-3.527) | | | | | | (-5.221) | (-5.159) | (-4.991) | (-3.632) | (-4.769) | | |
| 6. Dist.BNTHWY | -0.440 | -0.646 | -0.466 | -0.521 | | -0.532 | -0.459 | -0.492 | - | | | | - | -0.426 | -0.280 | -0.328 | -0.255 | -0.439 | -0.531 | -0.552 | -0.634 | -0.502 | -0.201 | -0.443 |
| | (-9.075) | (-5.404) | (-7.092) | (-6.998) | | (-8.757) | (-12.344) | (-12.152) | | | | | | (-5.966) | (-3.445) | (-4.915) | (-5.788) | (-11.811) | (-13.084) | (-9.778) | (-7.009) | (-6.021) | (-4.090) | (-7.396) |
| 7. Dist.REC | | 0.453 | | | -0.362 | | | | - | | | | - | | | | | | | | | | 0.371 | 0.360 |
| | | (3.183) | | | (-3.782) | | | | | | | | | | | | | | | | | | (2.914) | (2.109) |
| 8. Att.CANAL | | -0.314 | | -0.431 | | | | | - | | | | | | | | | | | | | | | |
| | | (-2.038) | | (-3.581) | | | | | | | | | | | | | | | | | | | | |
| 9. Dist.BCACC | | | -1.129 | -0.571 | | | | | | | 0.913 | 6.533 | | | | | | | -0.920 | -1.252 | | | | |
| | | | (-6.987) | (-3.309) | | | | | | | (2.747) | 3.606) | | | | | | | (-3.607) | (-3.231) | | | | |
| 10. Dist.BEACC | | | | 0.665 | | | | | | | | | | | | | | | | | | | | |
| | | | | (3.423) | | | | | | | | | | | | | | | | | | | | |
| 11. Dist.ALS | | | | | | | | | | | | | | | | | | | | | | | | |
| Constant | 15.522 | 14.765 | 9.528 | 8.861 | 6.750 | 6.326 | 8.379 | 14.467 | - | 8.577 | 6.873 | -6.923 | - | 9.127 | 9.464 | 9.573 | 6.196 | 8.589 | 10.888 | 11.980 | 4.800 | 7.866 | -19.416 | 24.187 |
| F-Statistic | 41.231 | 15.597 | 54.168 | 42.545 | 32.867 | 51.985 | 116.534 | 82.902 | - | 7.234 | 10.646 | 12.361 | - | 35.590 | 11.870 | 24.161 | 33.502 | 69.966 | 86.979 | 43.057 | 24.588 | 23.183 | 40.057 | 19.014 |
| Ajusted $R^2$ | 0.481 | 0.286 | 0.554 | 0.568 | 0.310 | 0.502 | 0.589 | 0.623 | - | 0.221 | 0.532 | 0.602 | - | 0.658 | 0.331 | 0.491 | 0.575 | 0.563 | 0.741 | 0.595 | 0.506 | 0.402 | 0.755 | 0.600 |
| Sample Size | 131 | 220 | 172 | 159 | 149 | 203 | 162 | 150 | - | 23 | 18 | 16 | - | 19 | 23 | 25 | 25 | 108 | 91 | 87 | 47 | 67 | 39 | 37 |

Note: Significant at 5 percent level

Variables: 1. Distance to Airport (Dist.AIR), 2. Distance to Bangkok CBD (Dist.CBD), 3. Distance to Mueng Mai Bang Phli (Dist.MMBP), 4. Distance to Cha Cheng Sao (Dist.CCS)
5. Distance to Nearest Major Street, 6. Distance to Bang Na-Trad Highway (Dist.BNTHWY), 7. Distance to Recreation (Dist.REC), 8. Attach to Canal (ATT.CANAL)
9. Distance to Bangkok-Chonburi New Highway Access (Dist.BCACC), 10. Distance to Bangkok Eastern Outer Ring Highway Access (Dist.BEACC), 11 Distance to Airport Link Station (Dist.ALS)

Model: * 1987, Variables include Variable 2-8 * 1995, Variables include Variable 1-8 * 2002, Variables include Variable 1-10 * 2009, Variables include Variable 1-11

Agricultural Land

**Bid-rent model (simple regression analysis).**

The result of the ANOVA of three periods of time is shown in table VI.7. The F-statistic indicates the results of the model of the average agricultural land values are significant for the years 2002 and 2009 at a 5 percent of level with the F-statistics of 37.900 and 6.12. That means the parameter estimates of the Dist.AIR variable for the years 2002 and 2009 are not equal to zero. Therefore, the Dist.AIR variables for both years fit into the regression model.

The results of the coefficient of the Dist.AIR are positively significant at the 5 percent level (Table VI.7). The coefficient of the Dist.AIR for 2002 and 2009 are 0.699 and 0.294, with the t-statistic of 6.156 and 4.482. Since the results of both coefficients are significant, the null hypothesis can be rejected. That means the slopes of both years are not equal to zero. However, the significance of the coefficient of both years represents the positive impact of the distance to the airport on the average agricultural land value, which is different from what was expected based on the hypothesis. The positive coefficients indicate that the average value of agricultural land in the southeast quadrant will increase with the increasing distance from the airport. The coefficient for 2002 is 0.699 and 2009 is 0.294, implying that the average agricultural land value in 2002 rather than in 2009 reflects higher prices farther away from the airport.

In addition, the different sign of the coefficient may be affected by externalities other than the airport. These externalities may cause the sensitivity of the average agricultural land value to reflect the prices more than the distance to the airport.

**Hedonic pricing model (multivariate regression analysis).**

The stepwise regression results (table VI.8) of agricultural land use in the southeast quadrant for the four periods indicate the significance of all four equations at a 5 percent level. The results of the F-statistics - 41.231 (1987), 15.597 (1995), 54.168 (2002), and 42.545 (2009) - suggest that all parameter estimates in the equations are nonzero, and they all fit into the stepwise regression models in order to explain the change in the average agricultural land value for the four periods. Additionally, the adjusted R-squares of the four models are 0.481 (1987), 0.286 (1995), 0.554 (2002), and 0.568 (2009). These results suggest about 48 percent, 29 percent, 55 percent, and 57 percent of the average agricultural land value in the 1987, 1995, 2002, and 2009 model can be explained by the independent variables entered in each equation.

The results of the stepwise regression equation for 1987 reveal three significant variables, which are Dist.CCS (-3.038), Dist.ST (-0.393), and Dist.BNTHWY (-0.440). As a result, the prices of agricultural land prior to the period of the new airport are most sensitive to the access to the Cha Cheng Sao CBD. With the negative significance of the variable, this would imply that the value of land reflects higher prices closer to the Cha Cheng Sao CBD. In terms of the accessibility to the transportation networks, the distance to Bang Na-Trad and direct access to main streets are still negatively significant with the prices of agricultural land increasing as the land is located closer to these two factors.

After the proposal of the new airport site, the results of the 1995 equation indicate six significant variables entered into the equation. The six variables and their coefficients are Dist.MMBP (0.524), Dist.CCS (-2.201), Dist.ST (-0.344), Dist.BNTHWY (-0.646), Dist.REC (0.453), and Att.CANAL (-0.314). The results affirm the most important factor

of Dist.CCS variable with a negative impact on the values of land. This would imply that the price of agricultural decrease by 220.1 percent as the distance to Cha Cheng Sao CBD increases by 1 percent.

Another significant factor is the distance to the Muang Mai Bang Phli CBD (Dist.MMBP). The result suggests the negative impact of the Dist.MMBP variable on the land values as the price of land increase closer to the Muang Mai Bang Phli CBD. In addition, the prices of land also decrease as the distance to main streets and the Bang Na-Trad highway increase. In terms of accessibility to amenities, the results suggest that the prices of land would increase as the agricultural land is located farther away from the recreational areas. For another new significant variable, Att.CANAL, the result suggests the importance of the canal for irrigation, which could imply that the price of land would decrease as the distance to the canal increases.

For the 2002 equation, the results suggest four significant variables affecting the prices of land during the period of airport construction. The four significant variables and coefficients are Dist.AIR (0.677), Dist.ST (-0.238), Dist.BNTHWY (-0.466), and Dist.BCACC (-1.129). At this time, the prices of agricultural land are most sensitive to the distance to the new Bangkok-Chonburi highway with the prices decreasing by 112.9 percent as the distance to the nearest highway access increases by 1 percent. The second important factor affecting the values of land is the distance to the airport. Since the variable has a positive sign on its coefficient, this would imply that the prices of land reflect lower values closer to the airport. In terms of accessibility to transportation networks, the results suggest the negative impact of the transportation network on the

values of land. That means the prices of land would increase as the distance from main streets and Bang Na-Trad highway increase.

The results of final model of agricultural land value, the 2009 equation, reveal five significant variables, which include Dist.ST (-0.311), Dist.BNTHWY (-0.521), Att.CANAL (-0.431), Dist.BCACC (-0.571), and Dist.BEACC (0.665). The results suggest that the prices of land are most sensitive to the Bangkok Eastern Outer Ring highway, while the negative sign on the coefficient implies that the value of land would reflect lower prices closer to the highway access. On the other hand, the other three variables of the accessibility to transportation network (Dist.ST, Dist.BNTHWY, and Dist.BCACC) suggest a negative impact on the values of land. Thus, the price of land would decrease as the distance from direct access to the main street and the highways increases. Finally, the negative significance of the Att.CANAL suggests the prices of land reflect higher values closer to the canal because of the usage of the canal for irrigation.

Low-Density Residential Land

**Bid-rent model (simple regression analysis).**

In terms of the average low-density residential land value, the results of the model are shown in table VI.7. The results of the ANOVA indicate that the F-statistic of the three periods of time, 1995, 2002, and 2009, are significant with the F-value of 61.359, 35.245, and 34.111 respectively. In other words, all parameter estimates for all three periods of time are not equal to zero, and the natural log of Dist.AIR variables fit into all three-regression models to explain the change in the average value of low-density residential land.

In table VI.7, an analysis of the Dist.AIR coefficients of the three periods shows that the Dist.AIR variable is significant at the 5 percent level in 1995, 2002, and 2009, with the coefficients of 0.579, 0.663, and 0.771 and with the t-statistic of 7.833, 5.937, and 5.840 respectively. The positive sign on all three coefficients of the natural log of Dist.AIR would imply that the low-density residential land value increases as the distance to the airport increases. The coefficient for 2009, which is 0.771, implies that the average value of low-density residential land in the southeast quadrant is higher when it moves farther away from the airport compared to the other two time periods.

Moreover, the sign on the three coefficients does not match what was expected from the previous studies (Alonso, 1964; Crowley, 1973). The difference in the sign on all three coefficients may be due to exogenous factors, which react to the change of the average low-density residential land value rather than the Dist.AIR variable itself.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.8, the results of the four stepwise multiple regression equations for low-density residential land are significant at a 5 percent level with F-statistics of 32.867 (1987), 51.985 (1995), 116.534 (2002), and 82.902 (2009). Also, the adjusted R-squares for the four periods of time are 0.310 (1987), 0.502 (1995), 0.589 (2002), and 0.623 (2009), which means the average low-density residential land value is about 31 percent for year1987, 50 percent for year 1995, 58 percent for year 2002, and 62 percent for year 2009 with all significant independent variables entered into the equation for each time period.

The results of the 1987 equation indicate two significant variables affecting the values of low-density residential land. These variables and the coefficients are

Dist.MMBP (-0.501) and Dist.REC (-0.362). The results suggest the distance to the Muang Mai Bang Phli CBD is the most important factor affecting the price of land rather than the distance to the nearest recreational area. Since both variables have negative signs on their coefficients, this would imply that the price of low-density residential land would reflect higher value closer to the Muang Mai Bang Phli CBD and access to the nearest recreational area.

For the 1995 equation, the results of the stepwise regression model reveal four significant variables entered into the equation. The four variables and coefficients are Dist.AIR (0.369), Dist.MMBP (0.534), Dist.ST (-0.155), and Dist.BNTHWY (-0.532). The signs on the coefficients of the Dist.AIR and Dist.MMBP are opposite to the expectation of the hypothesis. Since the signs on both coefficients are positive, the results suggest that the prices of low-density residential land would increase as the distance from the Muang Mai Bang Phli CBD and the distance to the airport site increase. On the other hand, the results of the model also indicate the negative significance of accessibility to transportation networks. The negative signs on both Dist.ST and Dist.BNTHWY coefficients explain the negative impact of these variables on the prices of land. In other words, the prices of land would increase as the distance to main streets and the Bang Na-Trad highway increase.

During the period of airport construction in 2002, the results of the equation reveal two significant variables, which are Dist.ST (-0.261) and Dist.BNTHWY (-0.459). The negative signs on both coefficients affirm the negative impact of the variables on the prices of land, while the distance to direct access of Bang Na-Trad Highway has more influence on the prices of land rather than the distant to the main streets. This would

imply that the prices of land decrease by 45.9 percent as the distance from the direct access of Bang Na-Trad Highway increases by 1 percent compared to a 26.1 percent decrease in the prices of land as the distance from the main street increases by 1 percent.

After the opening of the airport, the results of the 2009 equation indicate the three significant variables entered into the equation, which include Dis.CCS (-1.649), Dist.ST (-0.309), and BNTHWY (-0.492). The negative signs on all three coefficients match what was intuitively expected in the dissertation hypothesis. An analysis of the coefficients shows that the Dist.CCS variable is the most influential factor affecting the price of land. As a result, the prices of low-density residential land decreases by 164.9 percent as the distance to the Cha Cheng Sao CBD increases by 1 percent. In terms of accessibility to transportation networks, the results suggest that the prices of low-density residential land reflect higher prices closer to the direct access to the main street and Bang Na-Trad highway.

High-Density Residential Land

**Bid-rent model (simple regression analysis).**

In terms of the average high-density residential land value for the southeast quadrant, the results of the ANOVA for the three periods are insignificant (table VI.7). That means all the parameter estimates of the natural log of DistAIR for the years 1995, 2002, and 2009 are equal to zero. This result can imply that the natural log of the Dist.AIR variable does not fit into the regression model in terms of describing the change in the average land value for high-density residential. One possible reason may be the smaller sample size (23, 18, and 16 observations of the grouping of high-residential land) in 1995, 2002, and 2009. Since the southeast quadrant is in the Samut Prakarn province,

which is a bit far to the east from the city, the development of multi-housing units in this area may slow down and be caused by a small number of the sample size. Moreover, the exogenous effects may affect the average value of high-density residential land rather than the distance to the airport.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.8, the results of the stepwise regression equations for high-density residential land are available for only three periods of time -- 1995, 2002, and 2009. The result does not include the 1985 equation because the sample size was not sufficient to run the stepwise regression analysis. Since data is available for the later time periods, the results of the stepwise regression indicate the significance of the model at the 5 percent level for all three periods of time with the F-statistic of 7.234 (1995), 10.646 (2002), and 12.361 (2009). The adjusted R-squares indicate the low relationship between dependent and independent variables for the first period with adjusted R-squares of 0.221 (1995), while the adjusted R-square of the 2002 and 2009 are higher with 0.532 and 0.692. The lower value of the F-statistic is due to the small sample size of this type of land use in the southeast quadrant.

The results of the three equations of 1995, 2002, and 2009 indicate that Dist.ST variables are consistently significant throughout the three periods of time with the expected signs. The coefficients of Dist.ST for the three periods are -0.132 (1995), -0.172 (2002), and -0.180 (2009). The results show that the values of high-density residential land would reflect higher prices closer to the direct access of main streets for the three periods of time. Furthermore, the results of the 2002 and 2009 model have a new significant variable, which is Dist.BCACC, entered into the equations. These signs on the

coefficients for both periods of time show the positive impact of the Dist.BCACC on the prices of high-density residential land. In other words, the prices of land would decrease closer to direct access of Bangkok-Chonburi New Highway for the years 2002 and 2009.

Commercial Land

**Bid-rent model (simple regression analysis).**

The results of the model of the commercial land value for 1995, 2002, and 2009 are shown in table VI.7. The F-statistics of the two periods of time, which are 2002 and 2009, indicate the significance of the model with an F-value of 9.851 for 2002 and 14.693 for 2009. The results of the F-statistic imply that the parameter estimates of the natural log of the Dist.AIR variables for 2002, and 2009 are not equal to zero. That means the natural log of Dist.AIR variables in 2002 and 2009 are fit into the regression equations to explain the change in the average value of commercial land.

An analysis of the Dist.AIR coefficients of the two periods of time is shown in table VI.7. The results indicate that the natural log of the Dist.AIR variable is significant at the 5 percent level in 2002 and 2009 with the coefficients of 2.760, and 2.784 with the t-statistic of 3.139, and 3.833. The significance of these two coefficients of the natural log of Dist.AIR indicates that the slopes of the natural log of Dist.AIR for both years are not equal to zero. Furthermore, the positive sign on the two coefficient of the natural log of Dist.AIR would imply that the value of commercial land increases as the distance to the airport increases. The coefficient of the natural log of the Dist.AIR of 2009 is higher than in 2002. This can imply that the average commercial land value in 2009 reflects higher prices further away from the airport more than in 2002. In other words, increasing

the distance to the airport by 1 percent will cause the price of land to increase by 27.84 percent for commercial land in 2009 compared to an increase of 27.60 percent in 2002.

On the other hand, the positive sign on the two coefficients does not match what was expected from the hypothesis of this study and of previous studies (Alonso, 1964; Crowley, 1973; Forsyth, 2004; Golaszewski, 2004). The difference of sign on the two coefficients must be caused by exogenous factors, which react to the change of the average commercial land value rather than the Dist.AIR variable itself.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.8, the results of the stepwise regression equation for commercial land are available for three periods of time (1995, 2002, and 2009). Similar to the model for high-density residential land, the result does not include the 1985 equation because the sample size was not sufficient to run the stepwise regression analysis. Since the data are available for the later time period, the results of the stepwise regression indicate the significance of the equation at a 5 percent level for all three periods of time with the F-statistic of 35.590 (1995), 11.870 (2002), and 24.161 (2009). In addition, the results of the adjusted R-squares indicate the relationship between dependent and independent variables for the three models are 0.658 (1995), 0.331 (2002), and 0.491 (2009). That means the average commercial land value is about 66 percent for year 1995, 33 percent for year 2002, and 49 percent for year 2009 by all significant independent variables entered into the equation for each period.

The results of the stepwise regression analysis for the 1995, 2002, and 2009 equations reveal only one significant variable of Dist.BNTHWY through the three time periods. The results affirm that the negative signs on the coefficients of Dist.BNTHWY

match what was expected from the dissertation hypothesis. The results suggest that the prices of commercial land reflect higher values closer to the direct access to the Bang Na-Trad highway through the three periods. This result supports one of the three elements of the retail structure of urban areas, which were described by Berry and Parr (1988). One element of this specialized area is highway-oriented ribbons, while the business developments tend to have high concentration in the area right next to the highway. Moreover, in no year did the results show the insignificance of the access to any CBD variables and access to the airport, which were omitted from the equation. One possible reason is because of the smaller sample size for all three models.

Manufacturing and Warehouse Land

**Bid-rent model (simple regression analysis).**

In terms of manufacturing and warehouse land use, the results of the model fit for the regression analysis for three periods of time are shown in table VI.7. The results of the ANOVA indicate the significance of all three periods of time with the F-statistic of 14.914 for the year 1995, 58.808 for year 2002, and 10.875 for year 2009. Therefore, these results imply that all parameter estimates of all three periods of time are not equal to zero, and the natural log of Dist.AIR variables fit into all three-regression models to explain the change in the average land value of manufacturing and warehouse land.

Next, the analysis of the coefficients of the natural log of Dist.AIR for the three periods of time is shown in table VI.7. The results of the coefficient of the natural log of Dist.AIR indicate a positive significance with the coefficients of 0.839, 1.604, and 0.951 and t-statistics of 3.862, 7.669, and 3.298 respectively. These results indicate the significance of the slope at 5 percent, which means the slopes of the natural log of

Dist.AIR of all three periods of time are not equal to zero. As a result, the average manufacturing and warehouse land value increases as the distance to the airport increases. With the comparison among all three coefficients, the result indicates that the average manufacturing and warehouse values in 2002 seem to reflect more on the price of land than in 1995 and 2009, with an increase of the average land value of 16.04 percent when the distance to the airport increases 1 percent. This result compares with the increasing of the average land value by about 8.39 percent in 1995, and 9.51 percent in 2009, when the distance from the airport increases by 1 percent.

However, the significance of the coefficients has a positive relationship to the distance to the airport, which is different from the hypothesis of this study and from previous studies (Alonso, 1964, Forsyth, 2004; Golaszewski, 2004; Flores-Fillol and Nicolini, 2006). The result of the different sign on all three coefficients may be caused by exogenous factors, which may reflect the change of the average value of manufacturing and warehouse land rather than the Dist.AIR variable itself.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.8, the results of the stepwise multivariate regression analysis of the four periods of time (1987, 1995, 2002, and 2009) for average manufacturing and warehouse land value indicate the significance of the equations at the 5 percent level with the F-statistics of 33.502, 69.966, 86.979, and 43.057. Considering the adjusted R-squared, the results of the adjusted R-square of the four periods of time are 0.575, 0.563, 0.741, and 0.595. Since the F-statistics are significant for the four periods of time, it is possible to reject the null hypothesis. Therefore, the results confirm that all parameter estimates in the four equations are not equal to zero. These results indicate

that the set of the independent variables of each year significantly represent the factors affecting manufacturing and warehouse land value in the southeast quadrant.

The results of the 1987 equation, prior the airport, reveal one significant variable entered into the equation, which is Dist.BNTHWY. The coefficient of the variable is -0.255. The result suggests that the prices of manufacturing and warehouse reflect higher values closer to the direct access of Bang Na-Trad highway with the prices decreasing by about 25.5 percent as the distance to Bang Na-Trad increases by 1 percent. At the same time, the model's findings show the insignificance of any CBD, which was omitted from the equation.

After the proposal of the future airport site, the results of the 1995 equation indicate the significance of two variables entered into the equation. The two significant variables and coefficients are Dist.ST (-0.199) and Dist.BNTHWY (-0.439). The results of the equation suggest that the prices of land are most sensitive to accessibility to Bang Na-Trad highway. As a result, in 1995 the prices of land decrease by 43.9 percent as the distance to Bang Na-Trad increases by 1 percent. Compared to the Dist.ST variable, it would imply that the prices of manufacturing and warehouse decrease by only 19.9 percent as the distance to main street increases by 1 percent.

During the airport construction and after the opening of the airport, the results of the 2002 and 2009 equations reveal the same three significant variables for each equation. The three variables and coefficients of the 2002 model are Dist.ST (-0.153), Dist.BNTHWY (-0.531), and Dist.BCACC (-0.920), of which the coefficients for 2009 are Dist.ST (-0.191), Dist.BNTHWY (-0.552), and Dist.BCACC (-1.252). The results of the signs on coefficients for both models match what was expected from this dissertation

hypothesis. The variable Dist.BCACC is the most consistently significant for both models. With the negative significance of the variable, this would imply that the prices of manufacturing and warehouse land decrease by 92 percent for 2002, and 125.2 percent for 2009 as the distance to the nearest access of Bangkok-Chonburi new highway increases by 1 percent. Moreover, the results also suggest the prices of land would reflect higher values closer to the main street and Bang Na-Trad highway for both models.

Vacant Land

**Bid-rent model (simple regression analysis).**

The results of the ANOVA for the three periods of time for the average vacant land are shown in table VI.7. The F- statistics indicate that the regression model of 1995 and 2009 are both significant with the F-value of 11.165 and 5.325. That means the parameter estimates of the natural log of average vacant land value in 1995 and 2002 are not equal to zero, and the natural log of Dist.AIR variable for 1995 and 2002 fit into the model in order to describe the change in the average value of vacant land.

Next, the consideration of the coefficient of both significant models will be taken into account to determine if those parameter estimates are significant (table VI.7). The analysis of the parameter estimates of Dist.AIR in 1995 and 2009 show that the Dist.AIR variables are significant at the 5 percent level in both periods, with the coefficient of 1.204 and 0.901 and the t-statistic of 3.341 and 2.308 respectively. The significant results indicate that the parameter estimates of the Dist.AIR for both years are not equal to zero. A positive sign on the coefficient for Dist.AIR would imply that the price of vacant land increases as the distance to the airport increases. The coefficient for 1995 seems to reflect the distance to the airport rather than in year 2009. Since the coefficient

of 1995 is 1.204 and of 2009 is 0.901, this would imply that, when the vacant land is farther away from the airport by 1 percent, the price of the vacant land will increase by about 12.04 percent. This can be compared to 2009, when the airport distance of about 1 percent will cause an increase the value of vacant land by about 9.01 percent.

In addition, the significance of the coefficients is a positive relationship to the distance to the airport, which is different from the hypothesis of this study. The result of the different sign on all three coefficients may be caused by exogenous factors, which may reflect the change of the average value of vacant land rather than the Dist.AIR variable itself.

**Hedonic pricing model (multivariate regression analysis).**

According to table VI.8, the results of the stepwise regression analysis of vacant land value for the four equations of 1987, 1995, 2002, and 2009 indicate the significance at the 5 percent level of all four equations with the F-statistics of 24.588, 23.183, 40.057, and 19.014. The results suggest that all parameter estimates in all four models are not equal to zero. Moreover, the results of adjusted R-squares for all four models are 0.506 (1987), 0.402 (1995), 0.755 (2002), and 0.600 (2009). The results of the adjusted R-square suggest a high relationship between the dependent and independent variables for each model. As a result, about 51 percent of the average vacant land value can be explained by the independent variables entered in the equation for the year 1987, while 40 percent, 76 percent, and 60 percent of the average price of vacant land can be explained by the independent variables in the equation for the years 1995, 2002, and 2009.

For the 1987 equation, the results of the stepwise regression model reveal two significant variables entered into the equation, which include Dist.ST (-0.474) and Dist.BNTHWY (-0.634). The results show that the prices of vacant land prior to the airport period are most sensitive to the distance to the Bang Na–Trad highway rather than the distance to main streets. This would imply that the prices of land decrease by 63.4 percent as the distance to Bang Na-Trad highway increases by 1 percent, while the prices of land decrease by 47.4 percent as the distance to main street increases by 1 percent.

Next, the results of the 1995 equation indicate the significance of two variables, Dist.ST and Dist.BNTHWY, similar to the previous model. The coefficients of these variables are Dist.ST (-0.319), and Dist.BNTHWY (-0.502). Similar to the 1987 equation, the prices of land in this period are most sensitive to the distance to the Bang Na-Trad highway. As a result, the prices of land would decrease about 50.2 percent as the distance to the Bang Na-Trad highway increases by 1 percent compared to the price of land decreasing by 31.9 percent as the distance to main street increases by 1 percent.

During to the airport construction, the results of the 2002 model reveal that three significant variables are entered into the equation. The three variables and coefficients are Dist.CCS (8.048), Dist.BNTHWY (-0.201), and Dist.REC (0.371). The result of the sign on the coefficient of the Dist.CCS is opposite from the expectation of this dissertation hypothesis. Therefore, the result suggests that the prices of vacant land in this time period would reflect the higher prices farther away from the Cha Cheng Sao CBD. In addition, the results suggest the negative impact of the Dist.BNTHWY variable on the land value, which means the prices of vacant land would decrease as the distance to the Bang Na-Trad highway increases. Also, the positive sign on the coefficient of

Dist.REC suggests that the prices of vacant land reflect higher prices farther away from the nearest recreational area. One finding for the result of the opposite sign on the Dist.CCS is because of the small sample size (39 observations) in 2002.

Finally, the results of the 2009 equation reveal three significant variables entered into the equation. The three significant variables and coefficients are Dist.CBD (-4.537), Dist.BNTHWY (-0.443), and Dist.REC (0.360). The results suggest that the prices of vacant land at this time are most sensitive to the distance to the Bangkok CBD. The negative sign on the coefficient suggests the price of vacant land after the opening of the airport would decrease about 453.7 percent as the distance to the Bangkok CBD increases by 1 percent. In terms of accessibility to transportation networks, the results suggest the negative impact of accessibility to the Bang Na-Trad highway on the prices of vacant land. Furthermore, the positive significance of the Dist.REC suggests the prices of land would be higher as the distance to the nearest recreational area increases.

Summary of Findings of the Southeast Quadrant

The summary of bid-rent model and stepwise multivariate analysis for all types of land use throughout the four periods of time reveal three principal aspects. First, the results of the bid-rent model for the southeast quadrant reveal the overall significance of the distance to the airport in this quadrant and show a positive impact on the land values. Two types of land use, low-density residential and manufacturing and warehouse, are positively significant throughout the three periods of time (1995, 2002, and 2009), while other types of land use are positively significant at some point of time. The results of bid-rent gradients also show that the distance to the airport has the most positive impact on the commercial land values in both 2002 and 2009 rather than other types of land use.

As a result, the overall significance of the distance to the airport in this quadrant shows positive impact on the land values. Because of a lack of clear planning and policies to promote economic growth in the airport area as well as the economic crisis in Thailand, economic development in the airport area has slowed down. Therefore, the airport has not had a negative impact on the values of land in the southeast quadrant as this dissertation hypothesis anticipated.

Furthermore, the positive impact of the proximity to the airport on the urban land value of the southeast quadrant may derive from the impact of the high accessibility of transportation arterials (Bang Na-Trad Highway and Teparak Road), the Muang Mai Bang Phli CBD, and the land use comprehensive plan of Samut Prakarn province. The Bang Na-Trad Highway is still the major eastern corridor to connect the Bangkok metropolitan area and the eastern part of Thailand, which includes the eastern seaboard. As a result, the manufacturing and warehouse can take advantage of the location adjacent to the major corridor with high accessibility to transportation networks to save transportation costs in order to deliver their products from their facilities to the market in Bangkok and the worldwide by using the eastern seaboard and air transportation. Therefore, many developments of medium and large scale manufacturers and warehouses tend to cluster along the along the Bang Na-Trad corridor in the southeast corner of the airport in order to generate the agglomeration economies. Also, developments of medium and small scale manufacturers and warehouses tend to cluster along Teparak Road and in the area of the Muang Mai Bang Phli Industrial Estate.

As a result of the clustering of these developments along the major corridors, the land prices along these corridors will be overwhelmed by the transportation accessibility

rather than the proximity to the airport. Furthermore, according to the land use comprehensive plan of Samut Prakarn province (appendix D) and the building codes, the area of the southeast corner of the airport in Bang Sao Thong district was indicated as commercial (red) surrounding by the medium-density land use (brown), while the outside area along Bang Na-Trad and Teparak Road were designated for manufacturing and warehouse land use (dark violet). Since these areas are not in the direction of the airport runway and air flight patterns, developers will be allowed to build their facilities in a larger scale compared to the area close to the airport.

For the residential and commercial land use in Bang Sao Thong district and Bang Bo-Klong Dan sub-center, the land use comprehensive plan, land use regulation, and building codes may play an important role in reflecting higher prices of land value in these areas in term of increased density of development. As a result, the prices of the land in the area of commercial and medium-residential land use can be higher than the area around the airport, where the limitations of the usages of land were taken into the account. Therefore, the prices of land around the airport could be overwhelmed by the land use regulation.

Moreover, the positive significance of the bid-rent gradients of all types of land use may be affected by other exogenous factors rather than the airport. These results seem somewhat unusual throughout the three periods of time. The results from the stepwise multivariate regression model help in understanding this effect.

Second, the results of the stepwise regression analysis affirm that, while other exogenous factors along with the distance to the airport are included in the equations, the distance to the airport becomes insignificant through the periods of the study for all types

of land use. This result may be due to the fact that other exogenous factors have more impact on the values of land than accessibility to the airport.

Third, the results of the stepwise multivariate regression models affirm that the accessibility to transportation networks, Dist.ST and Dist.BNTHWY, have a negative impact on the land values. In terms of direct access to main street, the results suggest that main streets, such as Theparak and Wat Sriwaree Noi Streets, have a negative impact on agricultural, low-density residential, high-density residential, manufacturing and warehouse, and vacant land. The developments of single and multi-family housing as well as smaller industrial businesses tend to have high concentration along major streets because of the high-accessibility and the advantage of the street front location. As a result, the major roadways reflect higher land values outward along them. In terms of the access to the Bang Na-Trad highway, the highway has a negative impact on the agricultural, low-density residential, commercial, manufacturing and warehouse, and vacant land. High accessibility to the highway dominates the development of single and multi-family housing, larger scale industrial businesses, and high-order retail businesses such as offices and specialized retails stores that thrive on scale and agglomeration economies. These types of land use tend to cluster along the highway corridor. Therefore, the land along major corridors will be developed intensively with compatible uses in proximity to take advantage of higher-accessible location and agglomeration economies.

# CHAPTER VII

# SUMMARY AND CONCLUSIONS

The overall research objective is to examine the relationship between the land values of six types of land use and the location of Suvarnabhumi International Airport. The Alonso bid-rent model is appropriate only for the northeast quadrant to estimate the impact of the airport on the land value with no interference from the access to CBDs and other exogenous factors, such as transportation costs and site characteristics. In addition, the bid-rent model was used not only to examine the impact of the airport on urban land values around the airport, but also to determine the spatial distribution of each type of land use around the airport area. The slope of the bid rent curve can explain the sensitivity of each type of land use to the effect of the airport, while the steepest slope indicates the strongest requirement of that type of land use in proximity to the airport. In other words, that type of land use will outbid other types of land use to locate closer to the airport.

The statistical analysis results of the model indicate the strength of this model, especially for the northeast quadrant, where the proximity to the airport provides a negative impact on the values of all types of land use with the significance of F-statistic and R-square. Furthermore, the gradient for commercial land use is the steepest among the six types of land uses through the three time periods. This result indicates that the land value for commercial land use is most sensitive to the location of the airport or has the strongest requirement for accessibility to the airport compared to the residential and manufacturing land use.

Moreover, the characteristics of the land use and the geographical constraints of the area can affect the prices of land for the northeast quadrant. Most of the land on the far side of northeast quadrant has been preserved for agriculture land and in some area is a flood plain area. Therefore, the prices of land on the far side of the northeast quadrant have not increased very much as compared to the area close to the airport. In terms of the land use characteristics, the area of the Lad Krabang sub center has generated intense development of commercial and residential activities because of the attractiveness of the King Mongkut's Institute of Technology, which opened in 1971. After the new airport project had been announced in 1995, developers began speculating on the land around the airport for future development. Therefore, the prices of land around the airport reflect the new airport project along with the increasing development around the King Mongkut's Institute of Technology.

In addition, the bid-rent gradients of the six types of land use activities decline dramatically through the three time periods because of the Asian Financial Crisis in 1997 and its impact on Thailand's economy. Because this crisis resulted in the decline of industrial businesses in the area, in 2002 and 2009 the low-density residential land outbid the manufacturing and warehouse land for locations closer to the airport. Furthermore, the eighth and ninth national economic development plans (1997-2001 and 2001-2006) promoted the area in Samut Prakarn province, south of the airport, to become an industrial zone. Therefore, the industrial businesses tended to relocate their plants to the area where the labor supplies are sufficient and government policies support their businesses.

For the northwest, southeast, and southwest quadrants, the results of the bid rent model are not supported by Alonso's urban market theory. The results of bid-rent model for these three quadrants indicate the positive impact of the airport on the urban land value, which is opposite to what Alonso stated in his theory. The reasons for these positive impacts may be derived from the effect of exogenous factors that affect the prices of land and make the proximity to the airport become a positive impact on the land values. Also, the exogenous factors may affect the prices of land and make proximity to the airport become less significant or insignificant for some types of land use.

The explanations of the positive impact can be explained by the intensity of the existing developments in the area of Ramkamheang and Bang-Kapi market and along the Bang Na-Trad highway. These developments occurred more than thirty years before the airport project, and they caused increasing density in the area. Therefore, the prices of land in the area of Ramkamheang, Bang Kapi market, and along Bang Na-Trad highway have increased in the last thirty compared to the airport area. Although the Suvarnabhumi International Airport is a mega project that attracts many developments to the area, the impact of the proximity to the airport is still overwhelmed by the proximity to the transportation arterials and high-density of the core area.

In the case of the Suvarnabhumi International Airport, the hedonic pricing model is helpful to examine the impacts of the airport among other exogenous factors on urban land values contained in the model, including physical factors such as distance to CBD, distance to airport, distance to transportation networks and facilities, distance to recreation, and a dummy variable for land attached to canal. The hedonic pricing model is also used to identify the significant variables that reflect the prices of land and to

examine the change in the land values over the four periods of time. The model is suitable to respond to all research questions with the significance of the F-statistic and the high R-square value. In addition, the results of the significances of the t-statistic of coefficient will represent the significance of the influential variables that affect the prices of land.

The statistical analysis results of the hedonic pricing model indicate the different outcome of the factors reflected the prices of land, which depend on the characteristic of each quadrant and available factors in the quadrant. For the northwest quadrant, the statistical analysis results of the multiple regression model show that the main physical factors shaping land values in the area through the four time periods for six types of land use were the distance to CBD and major street network. The distance to the Bangkok CBD, which showed an inverse relationship with all six types of land use activities, was a dominant factor in explaining the land value variation in the quadrant.

In addition, direct access to the main street is another dominant factor shaping land value in the area. Because of the advantage of locations attached to main streets, residential land will benefit from sites with high accessibility to transportation networks for work and other destinations. In addition, the stepwise regression results in the negative impact of the airport site on the land values, especially in 1995. When the first reports of the new airport were released in 1991 with a detailed description of the new airport location, the market for land around the airport reacted to the announcement. Moreover, the negative significance in 2009 of the distance to the airport for high-density residential, commercial, and manufacturing and warehouse land supports the just-in-time production and the migration of new employees into the area. Furthermore, the distance

to the Bang-Na highway, which had a positive relationship with land value, was important for commercial land use throughout the four periods of time.

For the northeast quadrant, the statistical analysis result of multiple regression analysis showed the consistently negative significance of accessibility to the main streets for all six types of land use through the four periods of study. Since the privilege of location close to the street provides high accessibility and high visibility to the transportation network, the price of land would reflect higher prices closer to direct access to main streets. In term of the distance to the airport, the statistical analysis results show an inverse relationship with land value and were important for only agriculture, high-density residential, and commercial land through the three periods of time (1995, 2002, and 2009), vacant land (1995 and 2002), and manufacturing (1995). This confirms that the land market for the five groups of land use activities reacted to the announcement of the airport site in 1991. Also, the analysis results indicate that the distance to the Bangkok CBD was a dominant factor with a negative impact on the values of land for low-density residential as well as manufacturing and warehouse land.

For the southwest quadrant, the main physical factors that consistently reflect the prices of land in the quadrant through the four time periods were the distance to the main streets and the distance to the Bang Na-Trad highway. These two dominant factors showed a negative relationship with all six types of land use activities through four periods of time. In terms of the distance to the airport, the results of the stepwise regression analysis consistently support the negative impact of the distance to the airport on the values of agricultural, commercial, manufacturing and warehouse, and vacant land for the 1995 period, when the land market for these types of land use activities reacted to

the announcement of the new airport site. After the opening of the airport, the results of stepwise regression analysis suggest the negative impact of the airport on the values of commercial land as well as manufacturing and warehouse land.

On the other hand, the distance to the airport shows a positive impact on the values of low-density residential because of the effects of noise pollution, regulation controls for runway use, and landing and takeoff schedules, which influence residents to move in the opposite direction from the airport expansion. In term of the distance to the CBDs, the Bangkok CBD and Samut Prakarn CBD are not significant for every type of land use throughout the four periods of time. However, in terms of the impact of the Bangkok CBD, the results indicate that the distance to the Bangkok CBD has a negative impact on the value of agricultural, low-density residential, commercial, and vacant land, while the distance to the Samut Prakarn CBD has a negative impact on the values of high-density-residential and on manufacturing and warehouse land. Accessibility to the two CBDs is the strongest influencing factor affecting the prices of all types of land.

Finally, for the southeast quadrant, the statistical analysis results show that the main physical factor reflecting the prices of land was the distance to transportation networks, which included the distance to main streets and the distance to Bang Na-Trad Highway. The distance to Bang Na-Trad highway, which showed an inverse relationship with five groups of land use activities (agriculture, low-density residential, commercial, manufacturing and warehouse, and vacant land) through the periods of study, was a dominant factor in explaining land value variations. The distance to the main street, which shows the negative impact on the land value, was important for five groups of land

use activities (agriculture, low-density residential, high-density residential, manufacturing and warehouse, and vacant land).

In the hedonic pricing model, one explanatory variable that should be included is the geographical constraint, which is flood plain area. This variable is important to reflect the prices of land on the east side of the airport. However, to create the variable, it is quite difficult to determine which parcels of land are in the direction of flooding or in the area of the flood plain because of the unavailability of existing and historical data. This variable should not be ignored and should be included when the data are available in the future.

## Limitations and Benefits

There were some concerns about the reliability of the data used in this research. The first concern involves the use of different areal units for assessing land value for different time periods. While the land value assessments for 1987 and 1995 were conducted for zone block, the land value assessments for 2002 and 2009 were conducted for grid block. The Treasury Department of the Ministry of Finance was responsible for using two different areal units for conducting land value assessment. Clearly, this may affect the investigation of the overall trend of land value assessment, which is not readily apparent. However, the large sample sizes of land value data for each land use activity, quadrant, and time period used for the statistical analysis should overcome whatever impact the use of different areal unit the land value data may have.

A second concern for this research is the availability of the historical data. With the lack of historical data format for land value assessment by the Thai government, most of the historical land value assessments are in a paper-based format. Therefore, some of

them have been lost, and some of them are damaged. Since the study area covers about 576 sq.km (222.4 sq. mile) of surface land, the data of land value assessments have to be collected from more than 10,000 pages of hard copies. However, some of data of land values are not available because of the lack of historical data from the Treasury Department of the Ministry of Finance. Missing land value data in some areas may affect the accuracy of the results of the analyses.

A third concern involves the availability of aerial photos for the study. Since the study area is very large, it was difficult to find aerial photos that covered the entire study area. The aerial photos of 1987 and 1995 were in hard-copy format and were in a different scale. By using digital aerial photos of 2002 as the base map, which included the coordinate system in the map, the aerial photos of 1987 and 1995 were scanned and overlayed on the base map of 2002 by using a GIS program. The different aerial photo formats caused a distortion of the picture when overlaying pictures on the base map. The results of the distortion made it difficult for measuring distances.

The findings of this dissertation should be of value to regional and urban development planners in Thailand, the Thai government, and real estate developers. The contribution of the research findings to a mega project like Suvarnabhumi International Airport can help urban planners understand the real impacts of the airport on the distribution of the land use activities around it, such as residential, commercial, and industrial, and prepare better land use plans and policies for the future use of land in that area. Also, the analytical methods of the dissertation can be used as foundation models for future researchers to estimate the impacts of other mega projects, such as mass transit terminals, museums, stadiums, or mega malls, on urban land values.

Moreover, the results of the bid-rent model can determine the impact of the airport on each type of land use, and the Thai government can then use these results to plan the infrastructure and public utilities to support growth in the area. In general, the public also benefits directly from better planning decisions made by authorities and by the judicious allocation of public money for facilities to support the uses of land in the area. For example, if the location closer to the airport is suitable for commercial businesses, the government can prepare the land, public utilities, public transit, and policies to encourage commercial developers to build their businesses in the designated area. Furthermore, if the land farther away from the airport is suitable for the manufacturing and warehouse, the government may encourage industrial businesses to relocate their facilities to the desirable areas by providing the suitable land, infrastructure, policies, and intensive programs. Additionally, real estate developers can use the findings of this dissertation as a tool to determine the best location for profitable developments.

In terms of the contribution of the stepwise multivariate urban land value model, the analysis findings should benefit urban planners to understand factors other than the airport itself that influence the prices of land. By knowing the impacts of the various kinds of factors on the land values, urban planner can develop tools to evaluate and prepare plans, policies, regulations, and land use controls for future urban development.

Furthermore, since the impact of the CBDs and transportation accessibility are become more importance to overwhelm the impact of the airport, the policy makers can also provide policies to stimulate economic growth in the airport area to attract more development. Simultaneously, city planners should develop programs to attract

developers and challenge them to invest in the airport area by offering tax intensive programs, low interest for investment loans, and sufficient infrastructure to support the needs of development.

The findings of the dissertation are also beneficial to the local governments of both Bangkok and Samut Prakarn province. The airport is on the fringe of Samut Prakarn province, which is also close to the Bangkok jurisdiction. Both local governments can work together to provide appropriate land use plans and develop community development guidelines to stimulate the growth in the airport area, such as providing more commercial and manufacturing and warehouse land use for future land use comprehensive plans. In terms of residential land use, since the airport has generated noise pollution that has resulted in the residential developments moving farther away from the airport, both cities should create a buffer area of open space to protect the residents from the noise.

Furthermore, the application of the model will help real estate and land developers understand the factors that are reflected in the prices of land. Buying and selling land that has characteristics related to the influential factors will improve the reputation, image, and profits for the developers. For example, since the results of the study indicate the impact of transportation accessibility on the land value, developers can increase their property values by providing private roadways in their properties.

## Future Research

This dissertation on the impact of an airport on urban land values is the first study of its kind in Thailand. With the lack of available data in Thailand, it is quite difficult to generate similar models by using these primary data. Therefore, future research will focus on the same study, but more variables will be added into the model. The terms of

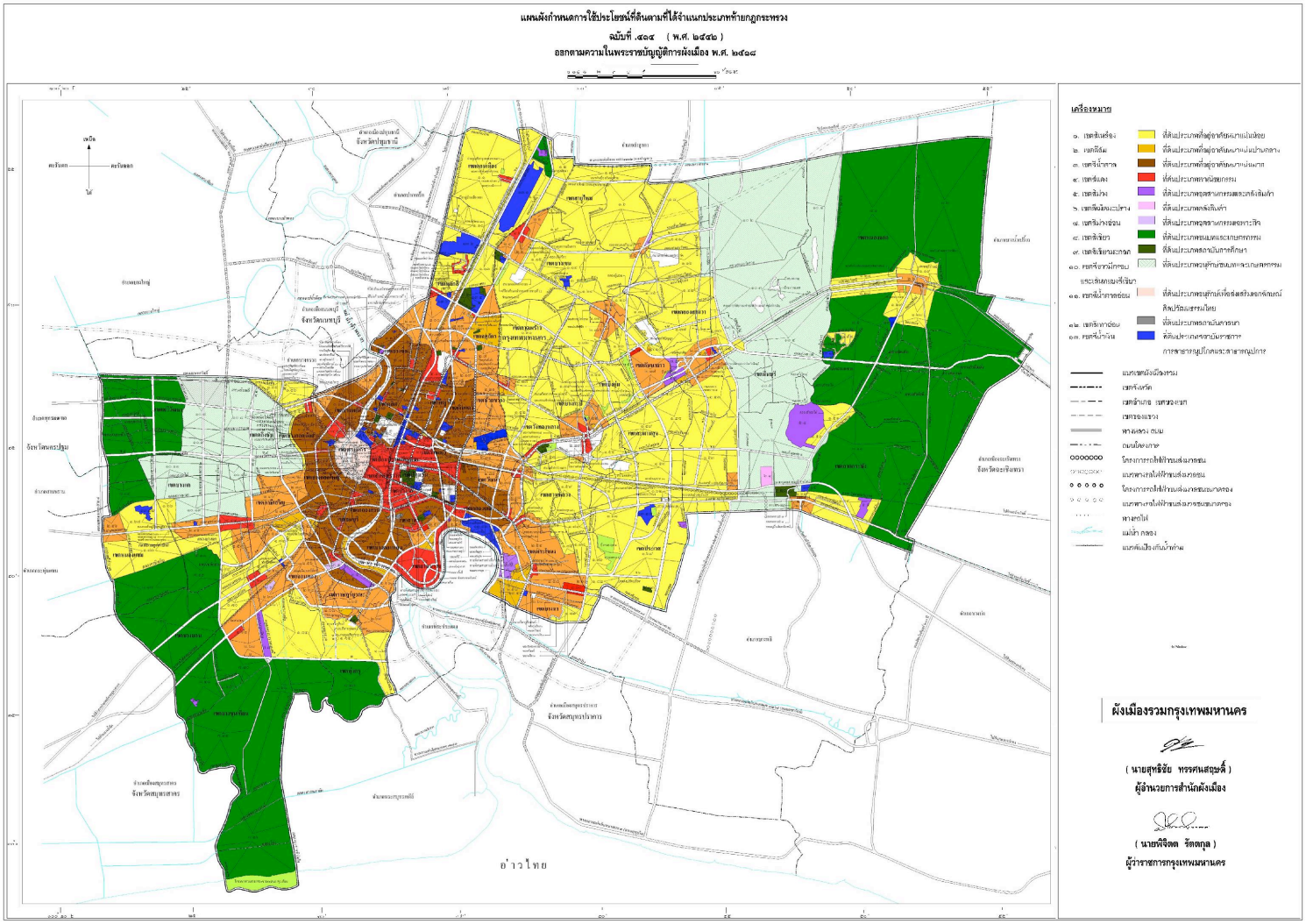
the hedonic pricing model will be used for the future studies but property values will be used instead of the land value to determine the effect of the airport. In addition to focusing on six types of land use, the hedonic pricing model will focus more specifically on each type of land use. For example, in terms of manufacturing and warehouse, the hedonic model will classify this type of land use into different types of industries. Moreover, commercial land use will be classified into different types of businesses. In terms of variables, other types of data, such as neighborhood, structure, location, condition, time, and policies rather than physical characteristics will be added into the model to determine their impacts on property values. The result of this research will represent the impact of property values relative to the airport based on each type of land use.

Another possibility is to do the same research on the impacts of the Don Muang International Airport on the urban land value. This future research will use the same analytical methods, the bid rent and stepwise multivariable urban land value models, to determine the impact of the airport on urban land value. The findings of the analysis will be compared with the results of this dissertation to determine the different impacts both airports have on urban land values.

The findings and comments of this dissertation provide information for both the public and private sectors about how the Suvarnabhumi International Airport has impacted urban land values. The results of the dissertation should encourage other researchers to use this dissertation as a guideline for their future research.

# APPENDIX A

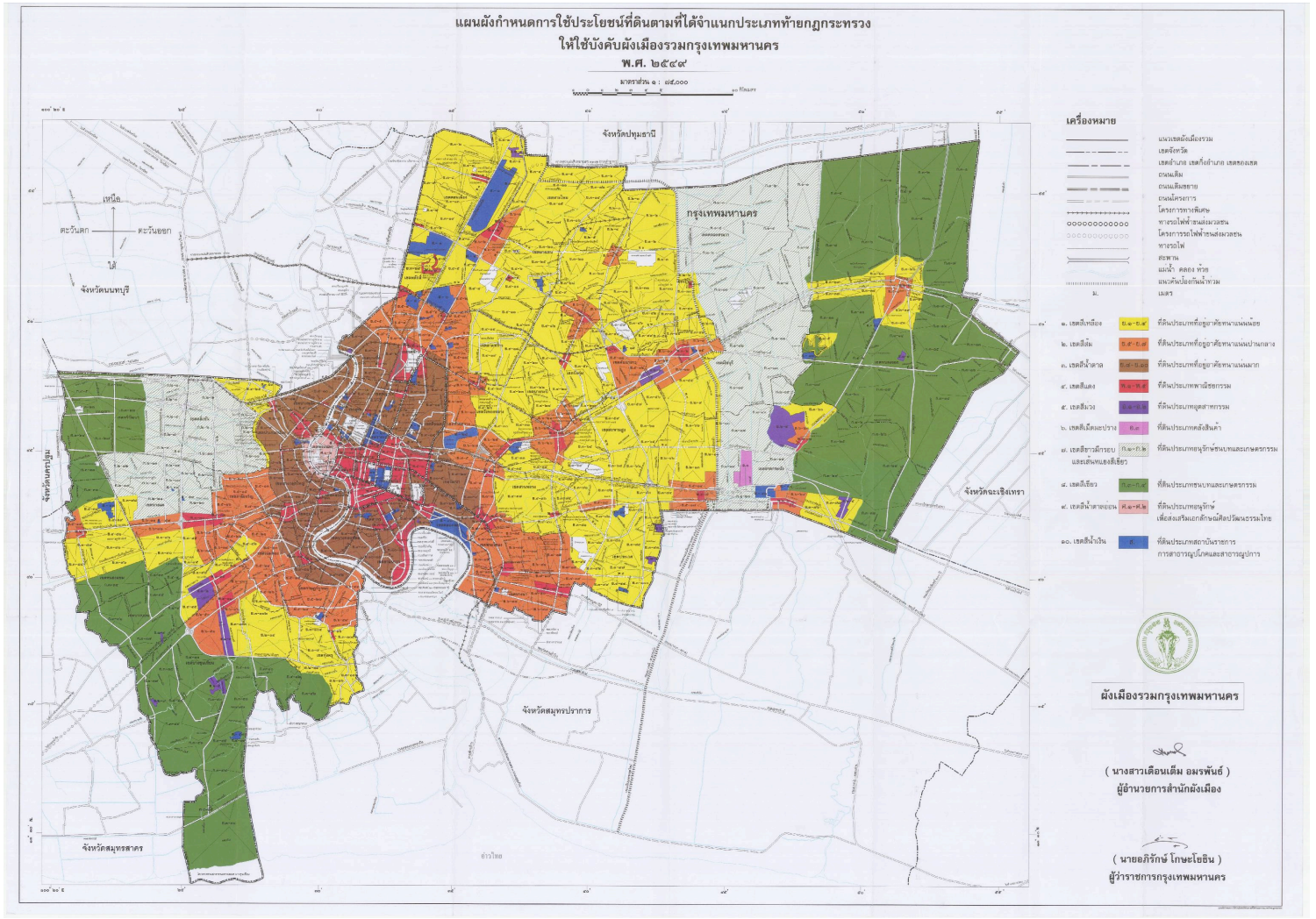
## THE MAP OF BANGKOK LAND USE COMPREHENSIVE PLAN OF 1999




**The Map of Bangkok Land Use Comprehensive Plan of 1999**

# APPENDIX B

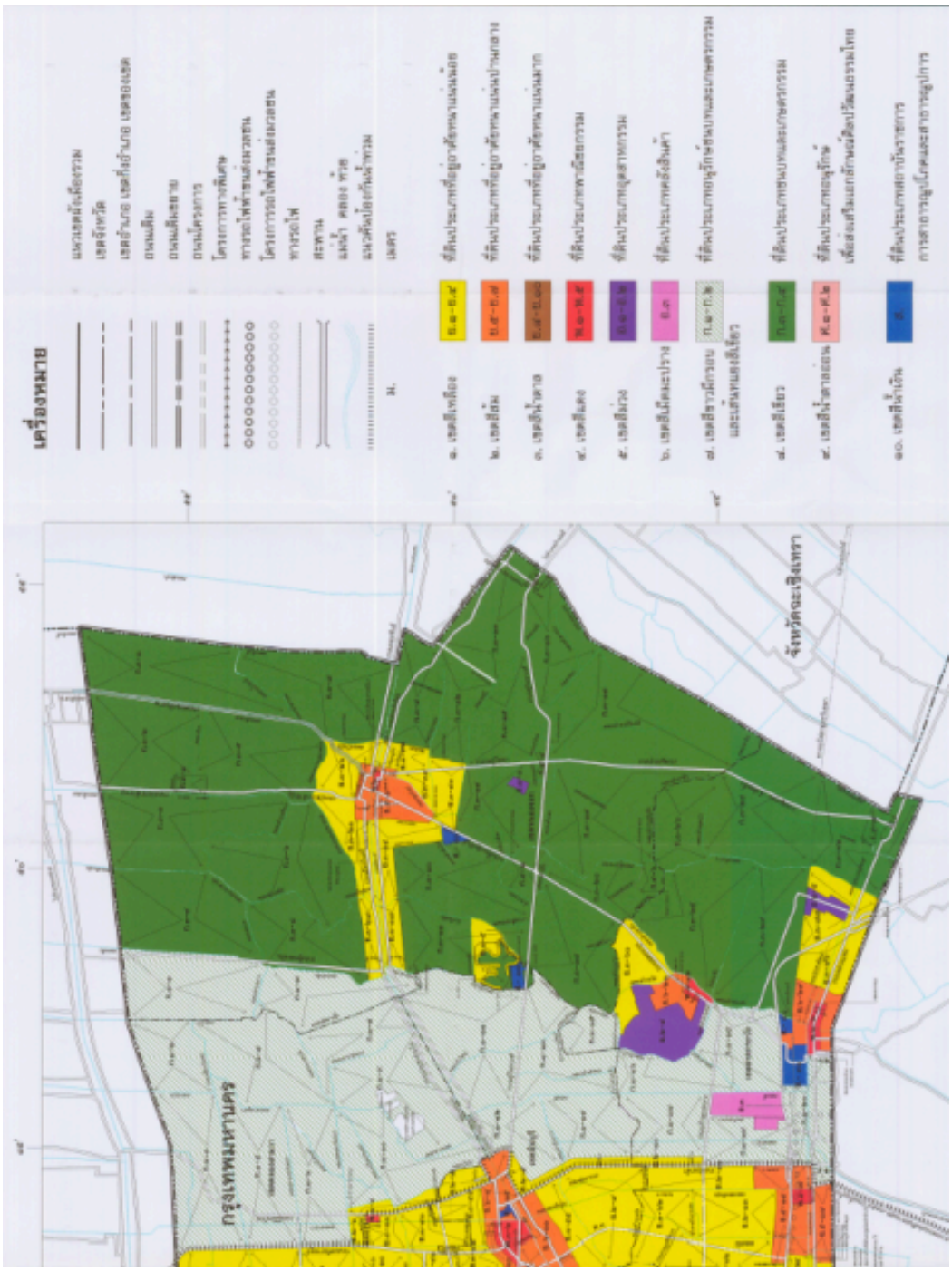
## THE MAP OF BANGKOK LAND USE COMPREHENSIVE PLAN OF 2006




**The Map of Bangkok Land Use Comprehensive Plan of 2006**

# APPENDIX C

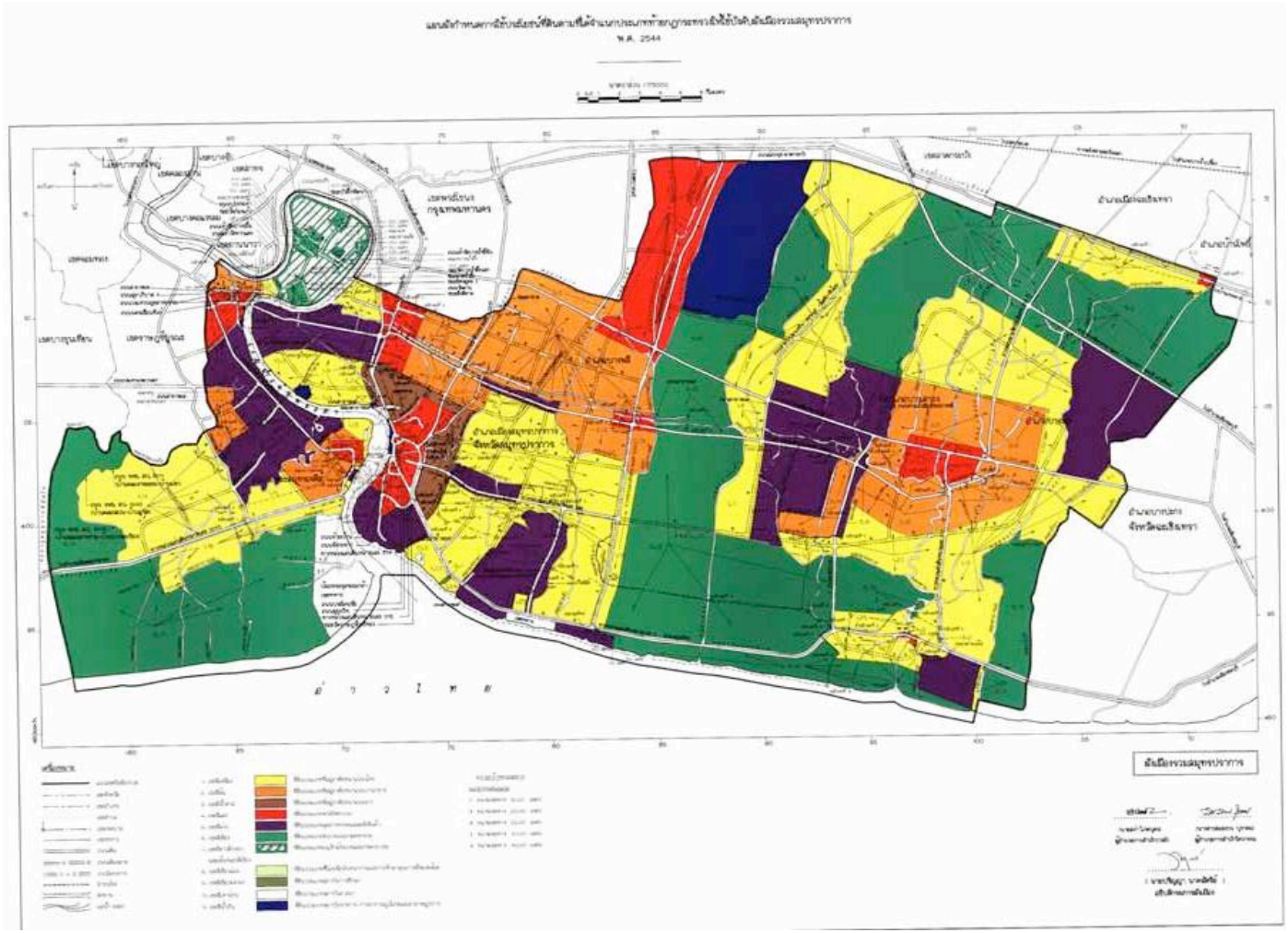
## THE MAP OF EASTERN BANGKOK LAND USE COMPREHENSIVE PLAN OF 2006




**The Map of Eastern Bangkok Land Use Comprehensive Plan of 2006**

# APPENDIX D

# THE MAP OF SAMUT PRAKARN LAND USE COMPREHENSIVE PLAN OF 2001



**The Map of Samut Prakarn  Land Use Comprehensive Plan of 2001**

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